S
622.342
L3ppd
1981

PLEASE RETURN

MONTANA DEPARTMENT OF STATE LANDS

STATE DOCUMENTS COLLECTION
MAY 28 1981
MONTANA STATE LIBRARY
930 E Lyndale Ave.
Helena, Montana 59601

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

PROPOSED PLAN OF MINING AND RECLAMATION
PLACER AMEX INC.
JEFFERSON COUNTY
MONTANA

Prepared by

Montana Department of State Lands

Gareth Moon, Commissioner
Montana Department of State Lands

Ralph Driear
Ralph Driear, Environmental Adm.
Montana Department of State Lands

Montana State Library
3 0864 1006 5539 1
APR 4 - 1990
FEB 3 1993

TABLE OF CONTENTS

INTRODUCTION Page

Agency Responsibilities and Inter-agency Relationships-- v
  Responsibilities of Montana State Agencies
    Department of State Lands------------------------ v
    Department of Health and Environmental Sciences-------------------------------------- vi

I. DESCRIPTION OF PLACER AMEX INC. MINING PROPOSAL

A. Proposed Mine Site and Property History

1. Property Location--- 1
2. Property History-- 1
3. Property Holdings--- 1
4. Permit History-- 1

B. Proposed Mining Plan

1. General Site Facilities
   a. Mine Site Development------------------------------------ 2
   b. Mill Site Development------------------------------------ 4
   c. Access and Haul Roads------------------------------------ 4
   d. Utility Corridors-- 7
   e. Tailing Impoundment and Monitoring Proposal------------- 7
   f. Mine Waste Dumps--- 16
   g. Surface Drainage Control--------------------------------- 16

2. Ore Processing
   a. Crushing--- 18
   b. Milling-- 20
   c. Reagent Leach and Value Recovery------------------------- 20
   d. Tailing Disposal--- 20
   e. Water Use-- 21
   f. Sewage Disposal-- 21

3. Reclamation Plan
   a. Mine Site-- 21
   b. Mine Dumps--- 21
   c. Tailing Impoundment and Diversion System---------------- 22
   d. Millsite--- 24
   e. Roads and Utility Corridors------------------------------ 24

4. Employment Requirements------------------------------------- 24

II. DESCRIPTION OF THE EXISTING ENVIRONMENT

Page

A. The Physical Environment

1. Location and Description of the Area 25
2. Topography 25
3. Climate 25
4. Geology 25
5. Air Quality 26
6. Soils 28
7. Hydrology 29
    a. Surface Water 29
        (1) On Site 29
        (2) Jefferson River 29
        (3) Boulder River 31
    b. Groundwater 31
    c. Impact 32
        (1) Mine and Dump Sites 32
        (2) Mill Site 33
        (3) Tailing Line 34
        (4) Water Use Line 36
        (5) Tailing Impoundment 36
            (a) Seepage 36
            (b) Impoundment Stability 37
            (c) Diversion System 39

B. The Biological Environment

1. Vegetation 40
2. Wildlife 40
    a. Terrestrial 40
    b. Fisheries 41

C. The Social and Economic Environment

1. Land Use 42
2. Income, Employment and Taxes 42
3. Human Health and Saftey 43
4. Archaeological and Historic Sites 43
5. Visual Resources 44
6. Recreation 45
7. Community Services 45
    a. Schools 45
    b. Housing 45

D. Significant Adverse Impacts that cannot be avoided if the proposals are implemented 45

E. Relationship Between Short-term uses of Man's Environment and the Maintainance and Enhancement of Long-term Productivity 45

F. Irreversible and Irretrievable Committment of Resources 46

III. MITIGATING OR COMPENSATING MEASURES Page

A. Laws and Regulation---------- 49

1. General Statement---------- 49
2. State Laws---------- 49
3. Federal Laws---------- 50
4. Jefferson County Laws---------- 50
5. Local Ordinances---------- 50

B. Reclamation Plans and Additional Mitigating Measures

1. Topography---------- 51
2. Air Quality---------- 51
3. Employee Health and Saftey---------- 51
4. Disposal of Hazardous Wastes---------- 51
5. Soils---------- 52
   a. Mine and Facility sites---------- 52
   b. Roads---------- 52
6. Water Resources---------- 52
7. Vegetation---------- 53
8. Wildlife---------- 53
9. Social and Economic---------- 54

IV. ALTERNATIVES TO THE PROPOSED ACTION

A. Introduction---------- 55

B. Administrative Alternatives Available to State Agencies------ 55

1. Department of State Lands---------- 55
   a. Approval of the Operating Permit for the life of the Operations---------- 55
   b. Suspension of the Permit---------- 56
   c. Denial of the Operating Permit---------- 56
2. Department of Health and Environmental Sciences---------- 56

C. Alternative Technology---------- 56

1. Underground Mining---------- 56
2. Alternative Processing---------- 56
3. Surface Drainage Control---------- 56
4. Tailing Disposal---------- 57
5. Ore Processing at Existing Facilities Elsewhere---------- 57
6. Neutralization of the Cyanide in the Tailing Impoundment- 57

V. Consultation and Coordination with Others---------- 59

A. Development of Statement---------- 59

B. Review of Statement---------- 59

Digitized by the Internet Archive
in 2014

https://archive.org/details/draftenvironment1981plac

Agency Responsibilities and Interagency Relationships

Responsibilities of Montana State Agencies

Department of State Lands

The Montana Board of Land Commissioners[1] (Board) and Montana Department of State Lands[2] (Department) are responsible for the administration of the METAL MINE RECLAMATION ACT (Title 82, Chapter 4, Part 3, MCA). Pursuant to its duties as administering agency for the METAL MINE RECLAMATION ACT, the Department must review and then grant or deny a hard rock mine permit or permit amendment within a period negotiable with the applicant to be not less than 60 days, nor more than 425 days after the submission of a complete permit application. The Department reviews applications for conformance with provisions of the METAL MINE RECLAMATION ACT regarding the method of operation, water control, air quality, mine waste disposal, topsoiling and for the reclamation of rules to accomplish the purpose of the METAL MINE RECLAMATION ACT, and the Department may adopt rules with respect to the filing of reports and the issuance of permits. To insure compliance with the METAL MINE RECLAMATION ACT and rules adopted pursuant to the law, the Department is required to make mine inspections and investigations as necessary.

The Department may not approve hard rock mining in areas which meet the criteria for selective denial provisions as specified in Section 82-4-351 of the METAL MINE RECLAMATION ACT. The Department may conduct studies or encourage others to conduct studies of hard rock mining and hard rock mining land reclamation.

When the operator is not in compliance with requirements of the METAL MINE RECLAMATION ACT, rules pursuant to the law, or orders of the Department and has not achieved compliance within time limits set by the Department, the commissioner shall serve a notice of noncompliance on the operator or if necessary, he shall order the suspension of the permit. After a hearing, the Board shall order the Department to revoke the permit if requirements specified in the notice of noncompliance, in the order of suspension, or if an order of the Board requiring remedial measures have not been satisfied.

---

[1] The Board of Land Commissioners consists of the Governor, Attorney General, Superintendent of Public Instruction, State Auditor and Secretary of State.

[2] The Commissioner of State Lands is the chief administrative officer for the Department of State Lands and is appointed by the serves at the pleasure of the Governor.

Montana Department of Health and Environmental Services

The Air Quality Bureau of the Department of Health and Environmental Sciences has primary responsibility for air pollution control activities in the State of Montana. These responsibilities include the review of new sources of air pollution to be located in the state, enforcing standards and ensuring that federal standards are achieved and maintained.

The Montana Clean Air Act (Title 75, Chapter 2, MCA) provides rule making authority to the Board of Health in regard to permits (Section 75-2-211). This rule making authority was exercised by the adoption of ARM 16.8.1102. This rule provides that, prior to the construction or operation of any new or modified equipment of certain categories, a permit be obtained from the Department of Health, Air Quality Bureau.

An application for the Air Quality Permit was filed by Placer Amex with the Department on May 8, 1980. The permit was granted on November 8, 1980 with approval contingent upon several conditions. A copy of the Department's analysis and permit conditions is contained in Appendix A.

In addition, the Surface Water Quality Standards require the following (ARM 16.20.633 (4)):

> *(4) Leaching pads, tailing ponds or holding facilities utilized in the processing of ore must be located, constructed, operated and maintained in such a manner and of such materials so as to prevent the discharge, seepage, drainage, infiltration, or flow which may result in the pollution of surface waters. The department may require that a monitoring system be installed and operated if the department determines that pollutants are likely to reach surface waters or present a substantial risk to public health.*
>
> *(a) Complete plans and specifications for proposed leaching pads, tailing ponds or holding facilities utilized in the processing of ore must be submitted to the department no less than 180 days prior to the day on which it is desired to commence their operation.*

The proposed tailing impoundment design will require the above review by the Department of Health and Environmental Sciences.

I. Description of Placer Amex Inc. Mining Proposal

A. Proposed Mine Site and Property History

1. Property Location

The proposed project is located in Township 2 North, Range 3 West M.P.M. and involves portions of sections 19, 20, 28, 29 and 30. The area is north of Interstate Highway 90, and west of State Highway 281, approximately four miles northeast of Whitehall, Montana.

2. Property History

The first claims were located in an area known as the Golden Sunlight group on April 1, 1890 by Anthony A. Hedley. In approximately 1895 a stamp mill was constructed on the property by the American Development and Mining Company following acquisition of the property from Hedley. This operation proved unsuccessful and was abandoned in 1905. From that period until 1946, during several changes of ownership, all ore mined was high grade and shipped to local smelters without milling. In 1946, the A. O. Smith Corporation of Milwaukee, Wisconsin, acquired the property and leased it to the Martin Brothers of Butte, Montana. The Martins erected a small 50 ton per day mill, which proved uneconomic. The White Development Company acquired the Martin Brother's lease in 1950 and constructed a 150 ton per day mill at the site of the present Placer Amex Inc. mine office. This operation continued until late 1955 when it was terminated by a fire. It should be noted that the area of the previous White Development mill and tailing impoundment are within the Placer Amex Inc. proposed permit amendment area.

Placer Amex Inc., formerly known as American Exploration & Mining Co., negotiated a lease with an option to purchase the property from the A. O. Smith Corporation in 1958. Ten years later, Placer Amex Inc. exercised that option and purchased the Golden Sunlight property. Exploration, development and production activities have been conducted by Placer Amex Inc. since 1958.

3. Property Holdings

Placer Amex Inc. is the owner of 24 patented mining claims, 202 unpatented lode mining claims, 21 mill site claims and 1,055 acres of fee simple land at the Golden Sunlight properties. The fee simple land also includes mineral ownership. In addition, Placer Amex Inc. owns an 80% interest in another 14 unpatented lode mining claims, of which thirty-six have been surveyed for mineral patent. All of the previously permitted 300 acres, and the 720 acres proposed to be permitted under Amendment 001 to Operating Permit 00065 are on land that is owned in fee simple by Placer Amex Inc., or on claims that will be included in the forthcoming patent proceedings.

4. Permit History

Placer Amex Inc. first applied for an exploration license on October 18, 1971. Exploration License 00019 was granted by the Department of State Lands (Department) on October 27, 1971, and is still in effect.

On May 24, 1974, Placer Amex Inc. made application to the Department for an operating permit covering 15 acres of the Golden Sunlight property. That permit was issued on June 14, 1974 under Permit Number 00056. Amendment 001 to Operating Permit Number 00056 was granted on July 10, 1974 for another 2.72 acres.

A much larger operating permit was requested on April 29, 1975 covering 4,113 acres of which 300 acres were to be bonded for surface disturbance to occur during the twelve months after the permit was granted. That permit was issued on June 27, 1975 under Operating Permit Number 00065. This is the permit under which Placer Amex Inc. is presently operating.

When Permit 00065 was issued, Placer Amex requested that Operating Permit Number 00056, Amendments 001 and 002 be voided, since some of the disturbed areas had been reclaimed, and the remaining areas were included within the new permit.

On May 23, 1980 Placer Amex Inc. requested an amendment to bond an additional 720 acres within the existing 4,113 acre permit area (figure 1). Amendment 001 to Operating Permit Number 00065, requests that the following area be bonded:

Section 19:	SE½NE¼, S½NE¼NE¼,	60 Acres
Section 20:	SW¼NW¼, W½SE¼NW¼, E½W½SW½,	100 Acres
Section 29:	E½W½NW¼, NW¼SW¼, S½SW¼, S½NW¼SW¼, SW½SE½	220 Acres
Section 30:	E½NE¼SW¼,	20 Acres
Section 32:	N½,	320 Acres
	TOTAL	720 Acres

All land descriptions are in Township 2 North, Range 3 West, M.P.M.

Because a patchwork of permitted, bonded and land proposed for amendment has occurred, it is noted that the facilities which are proposed under existing permit 00065 are (1) an open pit mine, (2) a new mill site, (3) the office and assay lab, previously the old mill site. The facilities proposed for approval under an amended operating permit include (1) mine dumps near the open pit mine (2) roads to the pit, and mill site, (3) utility corridors (4) the tailing system, and (5) the surface drainage diversion system (figure 1).

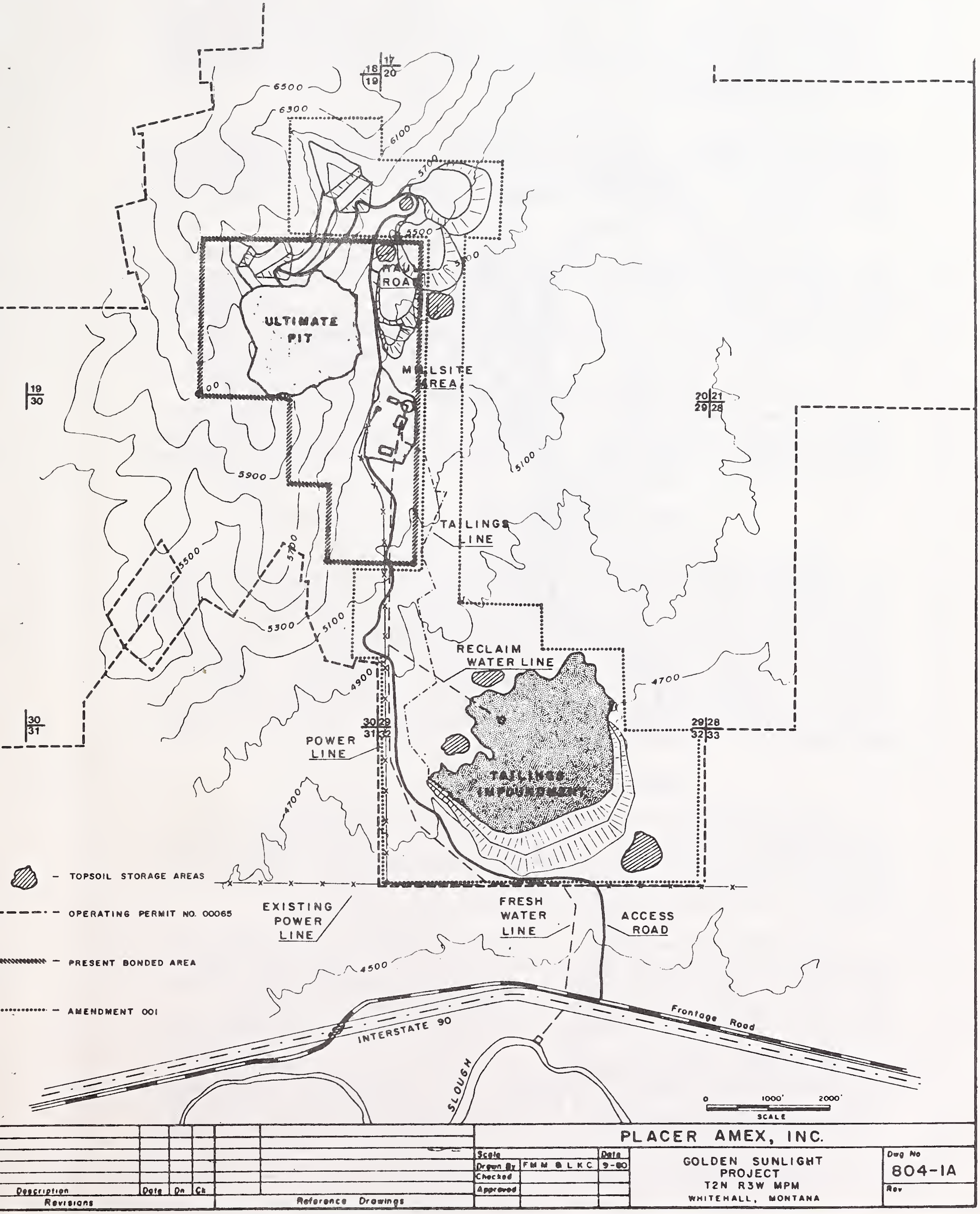
B. Proposed Mining Plan

1. General Site Facilities

a. Mine Site Development

Mining will involve excavation and removal of low grade gold ore and waste-rock. Economics dictate that a high volume, low cost mining method be used. The ore to be mined during the next ten years of operation occurs at the surface or at relatively shallow depths with ratios of overburden waste-rock to ore of less than two to one. Therefore, the conventional open pit mining technique is proposed as the most economically feasible method of mining. Mining levels would be established by drill - blast - load - haul techniques, employing drills, shovels,

Figure 1. General Project



front-end loaders, haul trucks and time-delay blasting methods. Benches would be 15-30 feet in height, with 2 to 4 benches under simultaneous development. All ore would be hauled down-slope to the millsite located southeast of the open pit. Waste-rock would be hauled from the mining areas to pre-selected waste dump sites located at appropriate elevations (figure 2). Mining operations would be conducted on a two shift per day and 5 day per week basis.

Drilling would be performed with conventional blast hole rigs. Each drill rig would operate an average of 12 drill hours per day on a 5 day week schedule. Rock fragmentation would be obtained with ammonium nitrate/fuel oil (ANFO) explosives on a blasting schedule of approximately twice a week.

Broken ore waste would be loaded by front-end loaders and shovels into 40 to 75 ton capacity end dump haul trucks. These loading and hauling units would operate an average of 14 hours per day on a 5 day per week schedule. Waste would be hauled and dumped onto the waste dumps shown in figure 2. Ore would be transported to the mill site crushing circuit via the haulage road, also indicated in figure 2.

Ancillary diesel-powered mining equipment would include crawler dozers, a motor grader and a water truck for road sprinkling. Smaller mine service equipment would include an air trac drill, lubrication and repair vehicles, an ANFO truck, mobile crane, road maintenance truck and light-duty pickup trucks.

b. Mill Site Development

The mill would consist of a crushing circuit, which would crush ore at an average rate of 500 tons per hour. The jaw crusher product would be screened, and the oversize material crushed in a 2-stage cone crushing circuit to produce the desired crushed product size. The final crushed product would be conveyed to the fine ore stockpile area. Crushed ore would be withdrawn from beneath the ore pile by feeders and conveyed to the wet grinding circuit in the mill building. Beyond the crushing circuit, a single rod ball mill grinding circuit would reduce the ore to a size appropriate for the agitating leach process. Refer to Flowsheep map (figure 3) and Mine Plan Map (figure 2).

c. Access and Haul Roads

Proposed permanent roads include an access road to the millsite from Interstate 90 frontage road, a haul road from active mine areas to the millsite, and miscellaneous access roads along the tailing pipeline and water pipeline. A number of temporary roads would be required for mine waste rock haulage to the waste dump areas (figure 2).

The access road would be a 30 foot wide improved gravel road, and would include approximately 2,000 feet of existing county road. The mine haul road and temporary waste haulage roads would be 40 to 60 feet wide. No perennial streams flow through any of the road routes. Culverts of adequate size would be installed in topographic depressions.

Cut slopes for roads would be less than 1.5:1 in unconsolidated materials and less than 0:1 in bedrock. Fill slopes would be less than 1.5:1. The total area proposed to be disturbed by the construction of roads is estimated at 48 acres, of which 24 acres is within the existing

Figure 2. Proposed Mine Site and Waste Dumps

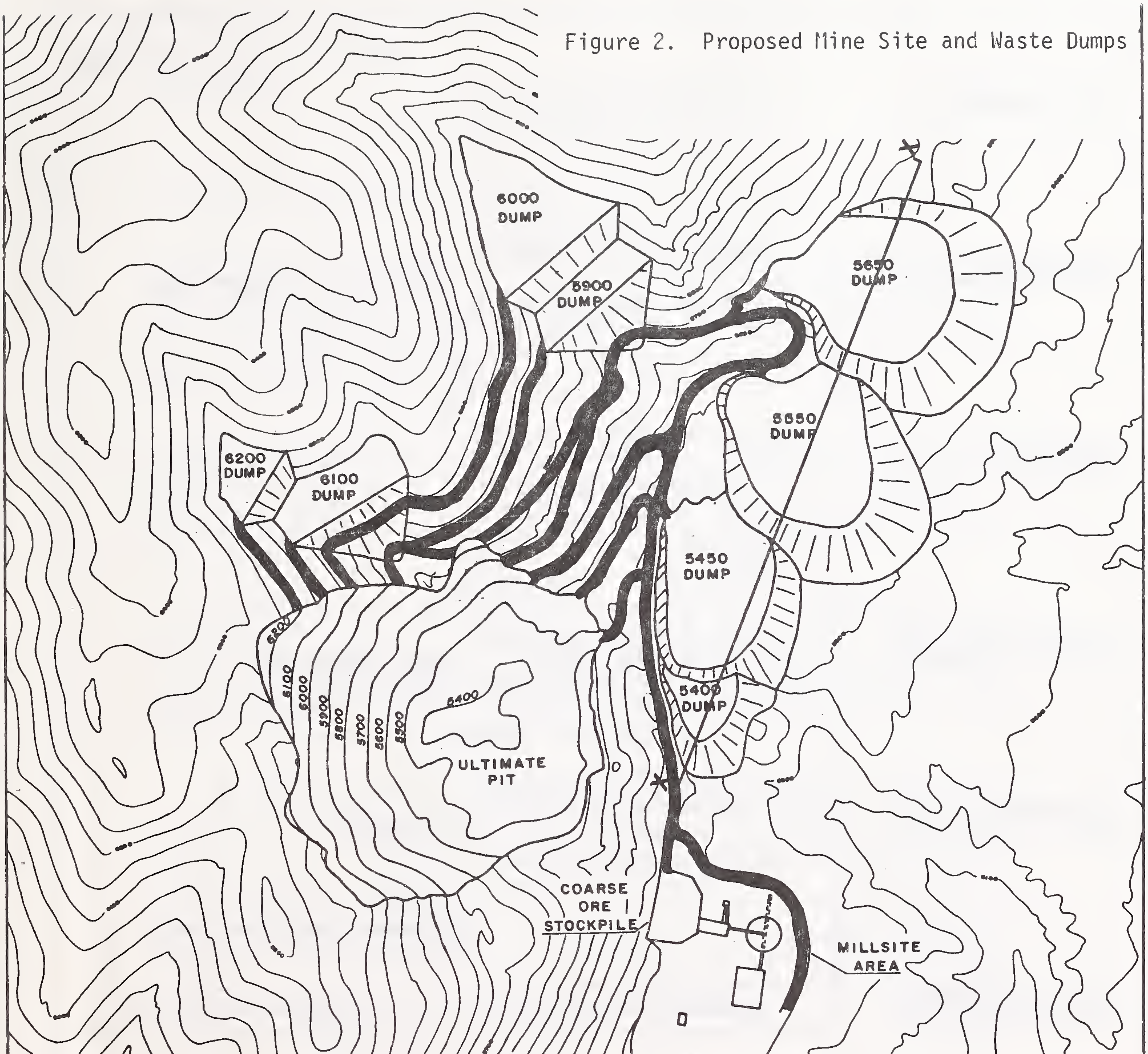
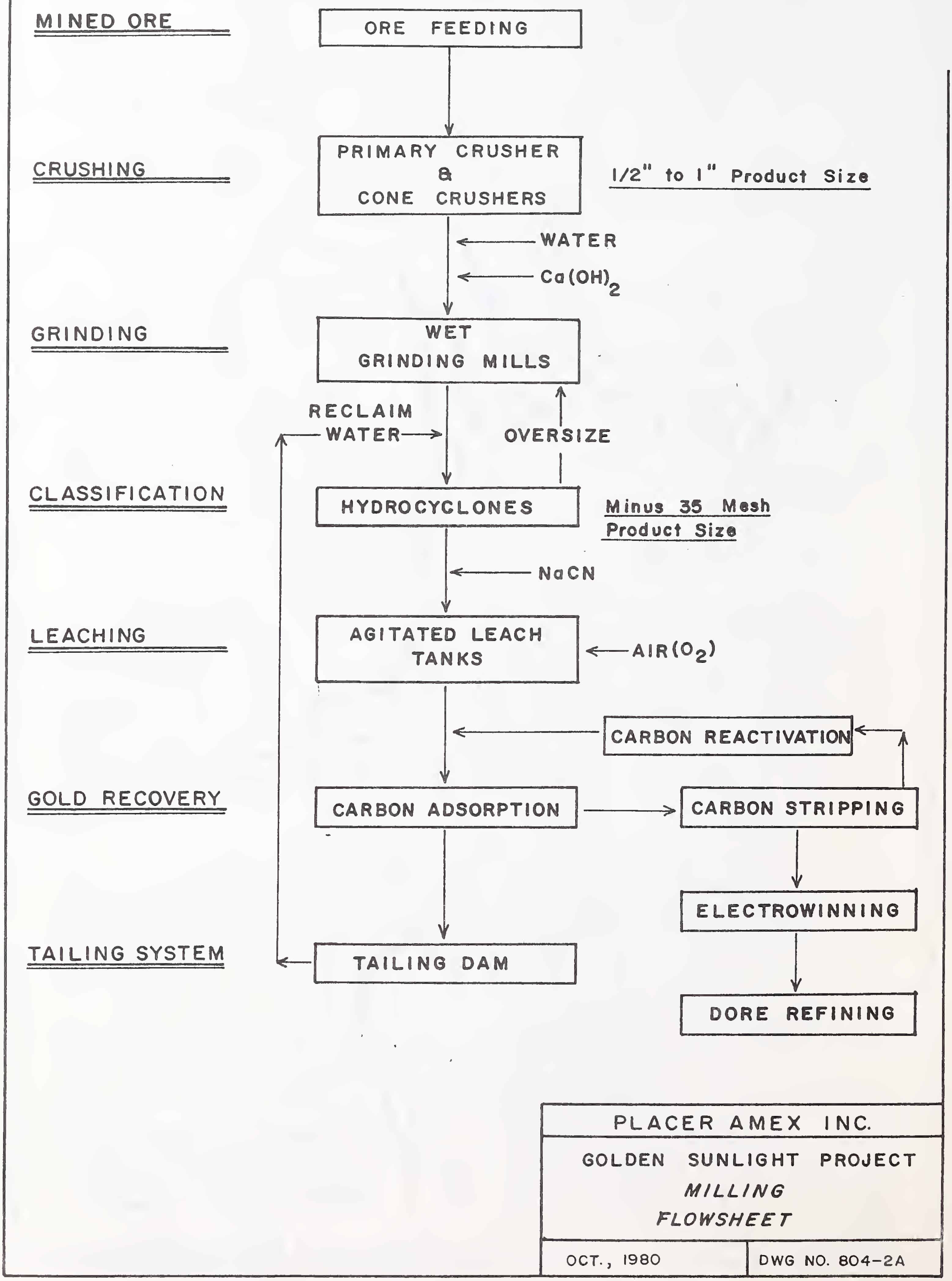


Figure 3. Milling Flowsheet



bonded area.

d. Utility Corridors

The proposed utility corridors would include power lines, water pipelines, and a tailing pipeline.

The power line would follow the existing power line right-of-way from Montana Power Company's existing 161 KV line to the millsite (figure 1). The existing line, however, would be replaced with a single pole, 25 KV line tapped from the existing main power line to provide service to the expanded facilities. Only temporary access to the power line right-of-way would be required to set new poles and lines.

An 8 inch steel buried fresh water pipeline would replace an existing 6 inch buried pipeline from Jefferson Slough to the south boundary of the north half of Section 32, then follow the access road route to the millsite. Where this pipeline route deviates from the access road, minor surface disturbance would be necessary to bury the pipe (figure 1).

The reclaimed water pipeline from the tailings impoundment to the millsite would parallel the fresh water pipeline routing, except for approximately 2,500 feet of line near the impoundment area. Minor surface disturbance would result during burial of an 8 inch pipeline, however, the line would be backfilled, graded and reseeded with a seed mixture recommended by the Soil Conservation Service.

The tailing pipeline would consist of approximately 8,900 feet of 12 inch high density polyethylene or plastic pipe laid on the surface on a prepared bed. The gradient of the line from the milling circuit to the tailing pond would be lessened by utilizing dropboxes for transport of the slurry. At the downstream end of each section a vertical drop-inlet cylindrical concrete stilling well (dropbox) would be located into which the slurry would pour. An outlet at the bottom would drain the slurry into the next section of pipeline. In this manner the slurry would be stepped down the hill to the tailing pond. The tailing line would be anchored to supports located on compacted fill. This bed would be approximately 15 feet wide to permit light duty vehicle access for monitoring of the pipeline.

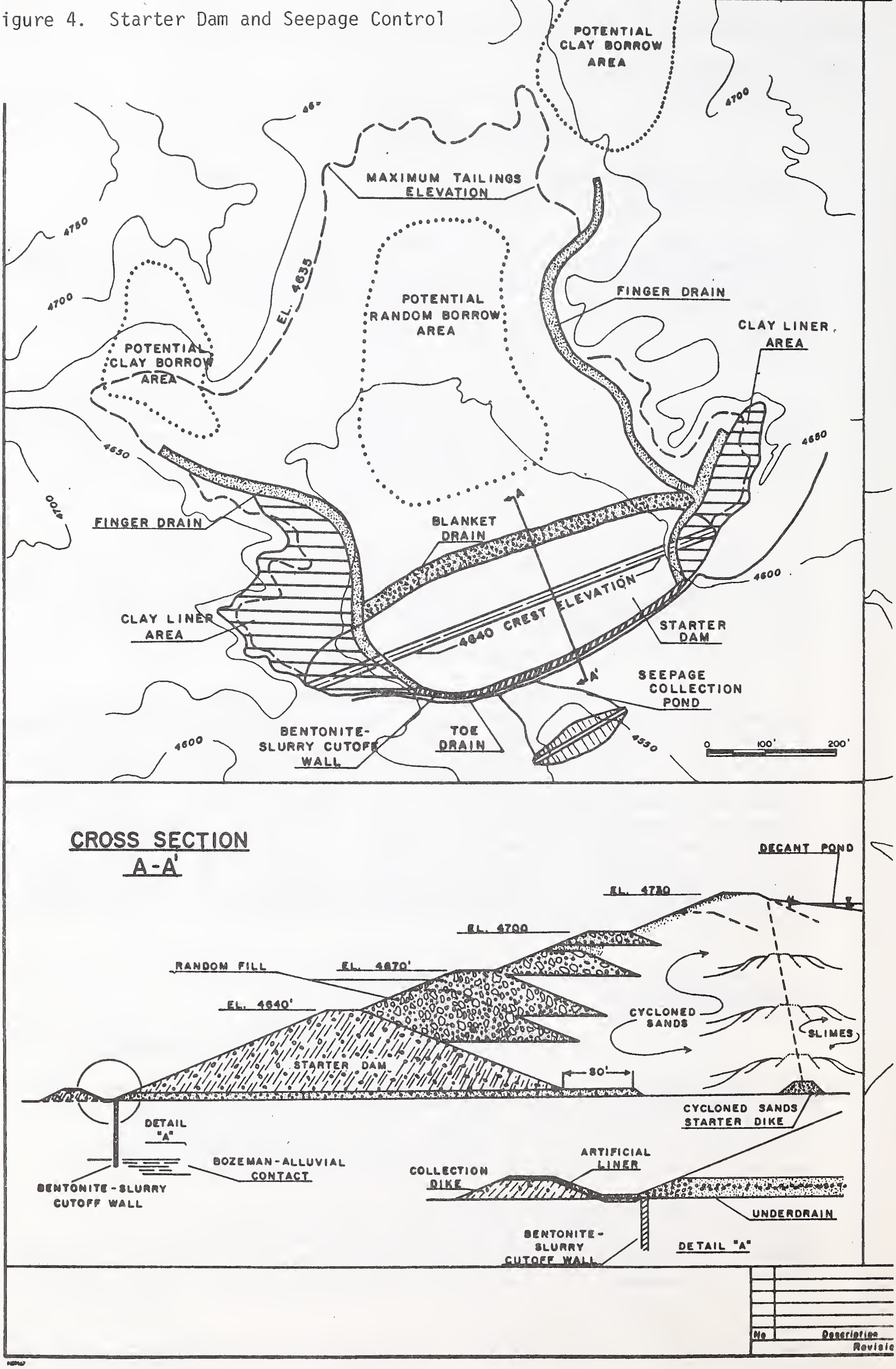
The total area proposed to be disturbed by all utility corridors is estimated at 8 acres.

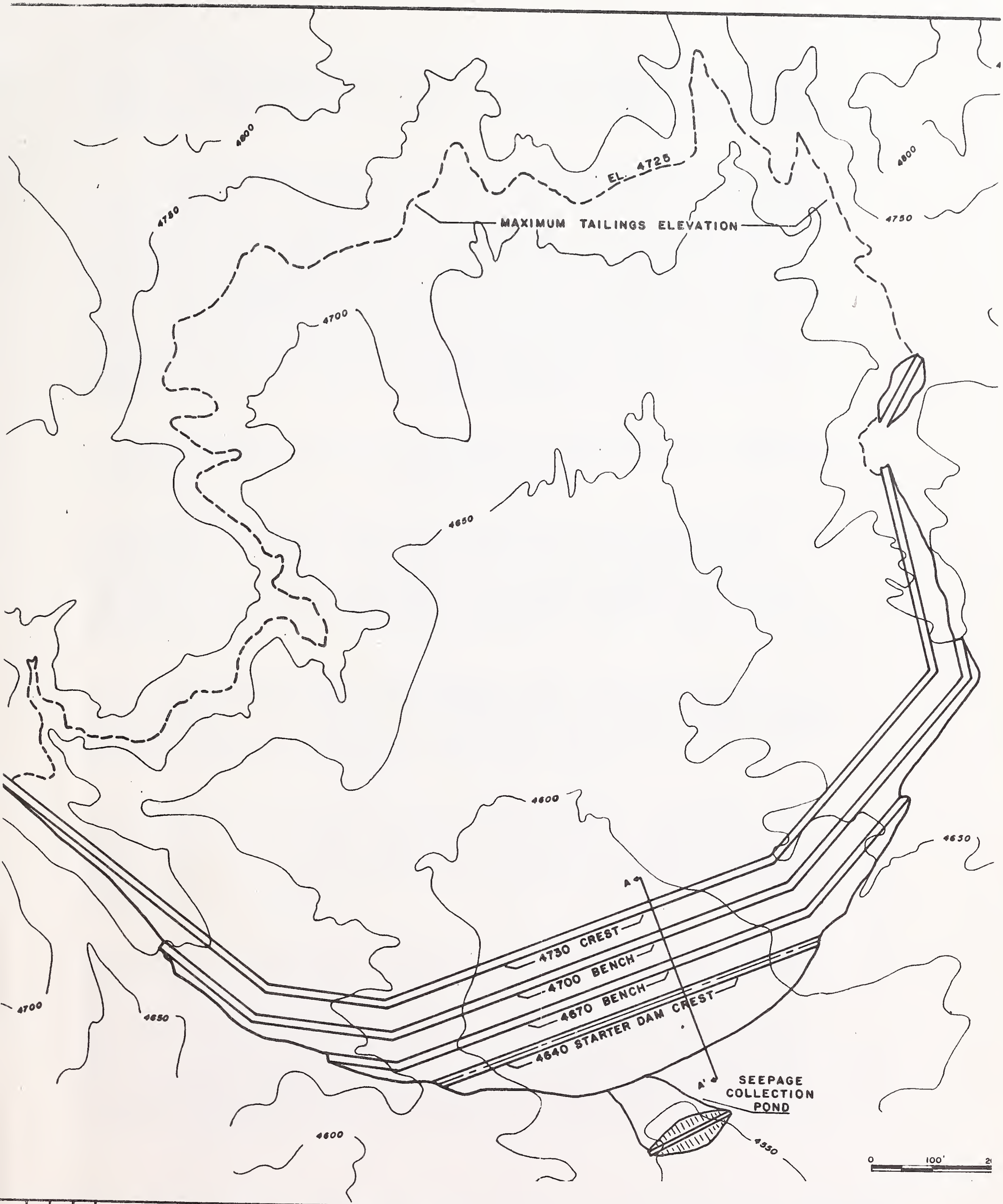
e. Tailing Impoundment and Monitoring Proposal

The proposed tailing impoundment would be constructed at the south end of Sunlight Gulch within the amended permit area, approximately one mile south of the proposed millsite. Size of the impoundment upon completion of the project is anticipated to be approximately 160 acres and would involve portions of section 29 and 32 (figures 4, 5 and 6).

Once ore is mined, crushed, milled and sent through the leach process, a slurry material of crushed rock, about 100 mesh in size, and water, called tailing, remains. The tailing would be transported to the tailing impoundment via pipeline, for permanent storage. Excess water

Figure 4. Starter Dam and Seepage Control





Date	Dn	Ck	No	Description	Date	Dn	Ck	
				Revisions				Reference Dre

Figure 5. Ultimate Tailing Impoundment

would be collected and returned to the millsite for re-use in the leach process. The proposed tailing pond is designed to operate in a closed-loop system, with no planned surface discharge of waters from the impoundment area.

During the early years of operation, the downstream dam face would consist mainly of borrow materials that will be revegetated sequentially, while coarse, wet cyclone sands used in dam construction would be deposited continually along the dam structure centerline. As the sands dried, between each depositional cycle, the sands would be spread into place and compacted with track-type equipment. Tailing located farther back within the impoundment area would be of a finer size fraction which will be in a flocculating-settling phase. In this phase, the fine solids would settle to a thick pulp density, and the excess water would be released to form the reclaim pond from which water would be returned by pumping to the mill circuit. Consequently much of this tailing area would be under water or be saturated by the reclaim pond.

Cross section and plan views illustrating details of the proposed tailing impoundment design are presented in figures 5 and 6. A discussion of the major components of the design follows.

A 2.5 foot thick bentonite slurry cutoff wall crossing the Golden Sunlight Gulch drainage immediately downstream of the dam would be established. The cutoff wall would extend about 3.0 feet into the Bozeman Group. It would be necessary to grade the segment of the dam foundation receiving the cutoff wall to constant elevation by cutting and filling. This would be necessary because of the fluid nature of the bentonite slurry.

The slurry cutoff wall would connect with a shallow clay cutoff trench which would extend on the upstream side of the two ridges at each end of the dam. This trench, in conjunction with a clay blanket extending about 200 feet up the slope, and a proposed finger drain system, would intercept tailing pond seepage at each end of the dam.

A 2.0 foot thick blanket drain extending beneath the starter dam, and for 50.0 feet upstream from its toe would also be constructed. The blanket drain would connect with the slurry cutoff wall and a collection ditch, leading to a reclaim water pond at the downstream toe of the dam. Dupont Typar filter fabric or an equivalent filter fabric would be used to encapsulate the drain.

Finger drains would be constructed just upstream of the cutoff wall extending along the ridges at each end of the dam. These drains would be 20.0 feet wide, 2.0 feet thick and encapsulated in filter fabrics in the same manner as the blanket drain. A drainage pipe, leading to the collection ditch downstream of the dam, would be placed at the bottom of the finger drains. Antiseep collars would be necessary for these pipes where they pass through the starter dam. The function of this system, and the blanket drain, would be to maintain a low phreatic surface, minimizing inflow into the drain system and increasing the factor of impoundment safety for both static and seismic conditions.

A homogeneous starter dam constructed of selected silty sand surface soils from within the impoundment area, or from upstream drainage channel excavation would be established. These soils would be compacted to at least 95 percent of maximum dry density. In addition, a small starter dike upstream of the starter dam and blanket drain, to allow initial containment of the cycloned sands, is a part of the impoundment design. Starter dam height is based upon the proposed milling rate and initial rate of dam construction. The starter dam would provide 1.5 years of tailing storage.

A stability zone would be constructed between the starter dike and the starter dam consisting largely of cycloned coarse tailing sands. The lower 10.0 feet of the zone would be entirely cycloned sands. As additional tailing storage space would become necessary, the height of the dam structure would be increased with phased lifts of the starter dike and lifts of random fill upon the starter dam as illustrated in figure 5. Ultimate height of the dam structure is anticipated to reach 180 feet during the life of the project.

During the initial placement of tailing, the drainage system filter fabrics would be carefully covered with cycloned sands to prevent the possibility of clogging with tailing slimes.

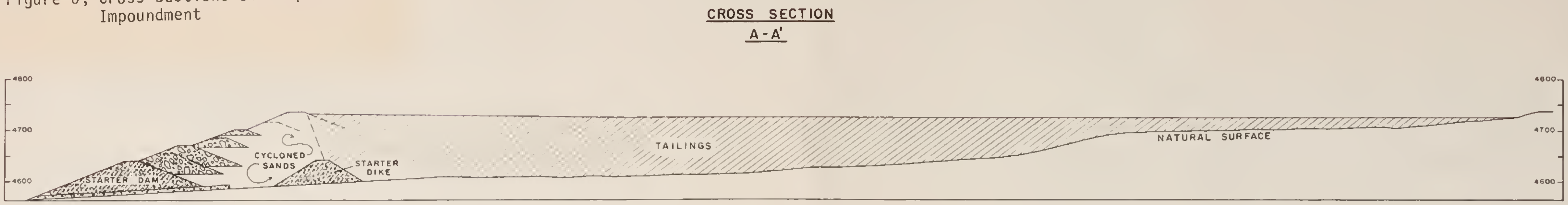
The largest demand for construction materials would be in the first five years of operation. During this period, insufficient cycloned tailing sands would be available to build the stability zone fast enough to contain the tailing slimes. Accordingly, silty sand borrow of the same type used for the starter dam would be used on portions of the embankment near the downstream face. Where borrow is used, it would be compacted to at least 95 percent of ASTM D698 maximum dry density.

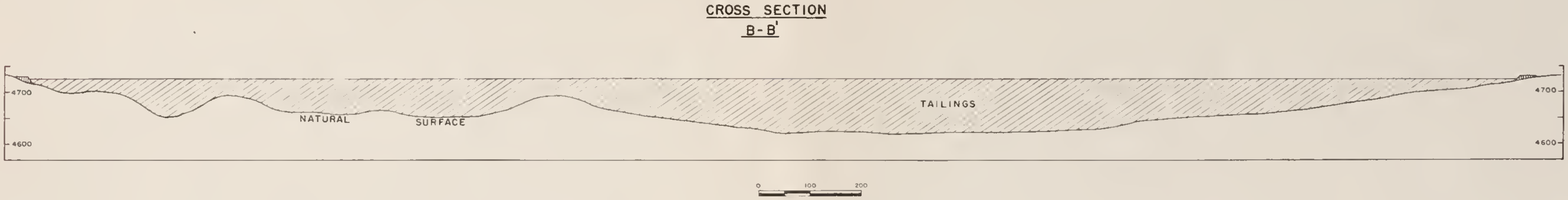
Where cycloned sands are used, they would be compacted with a dozer or other means so that relative density of about 65 percent is achieved. This is proposed to be accomplished by placing the material in 2.0 or 4.0 foot lifts and making four or five passes with the dozer or other vibratory equipment. The exact compaction procedures would be established in the early phases of construction to optimize construction efficiency.

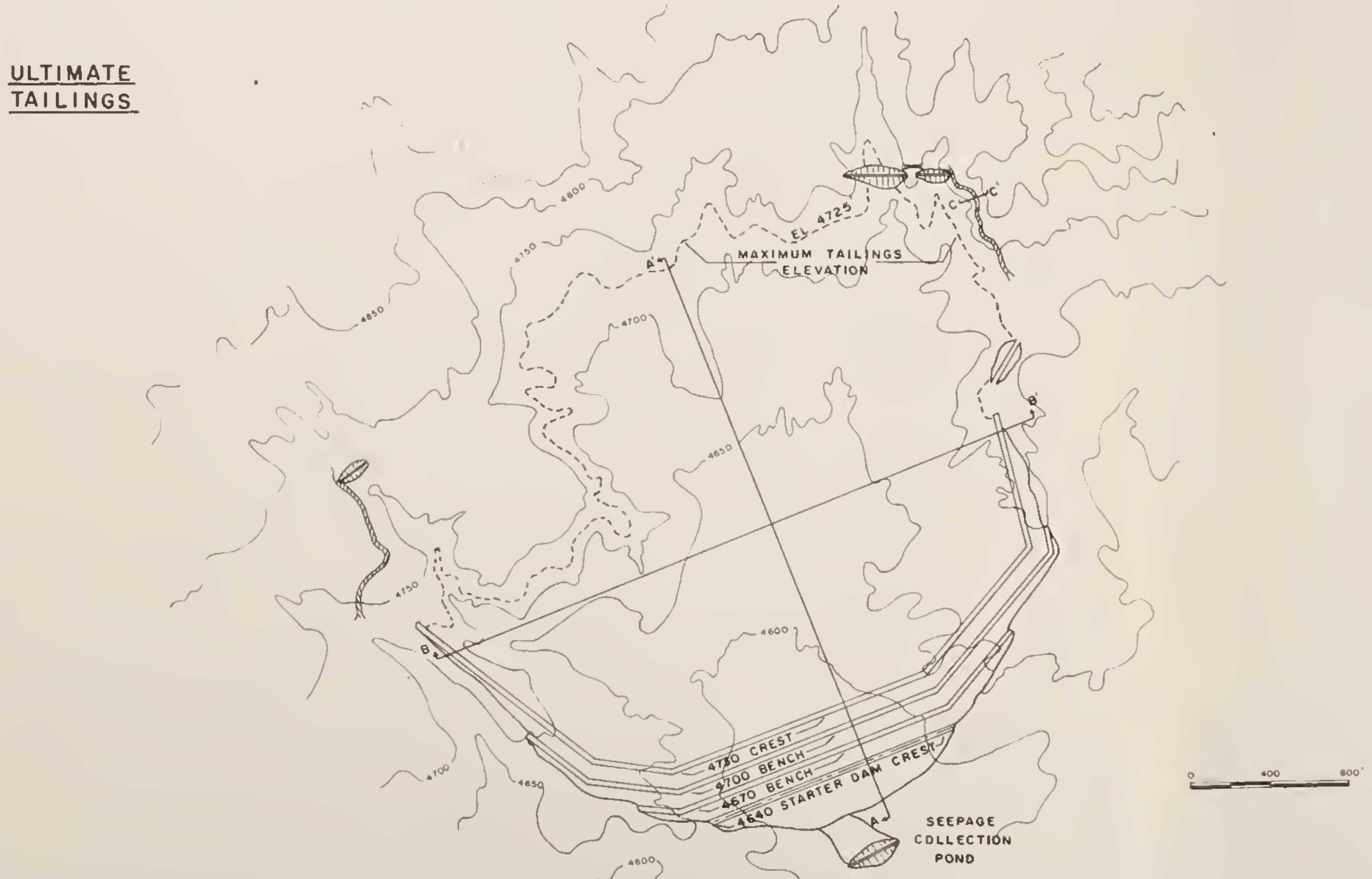
Diversion channels would be created upstream of the dam to minimize inflow of surface waters into the disposal area (figure 7). Excavation from these channels is proposed to be used in the starter dam construction. Hydrologic data in Appendix B depicts the estimated impoundment freeboard required to contain the 100 year storm should the diversion system be utilized during operation. Upon reclamation of the tailing impoundment site, some variation of the proposed diversion system could be developed to route both spring seepage and runoff away from the tailing impoundment area.

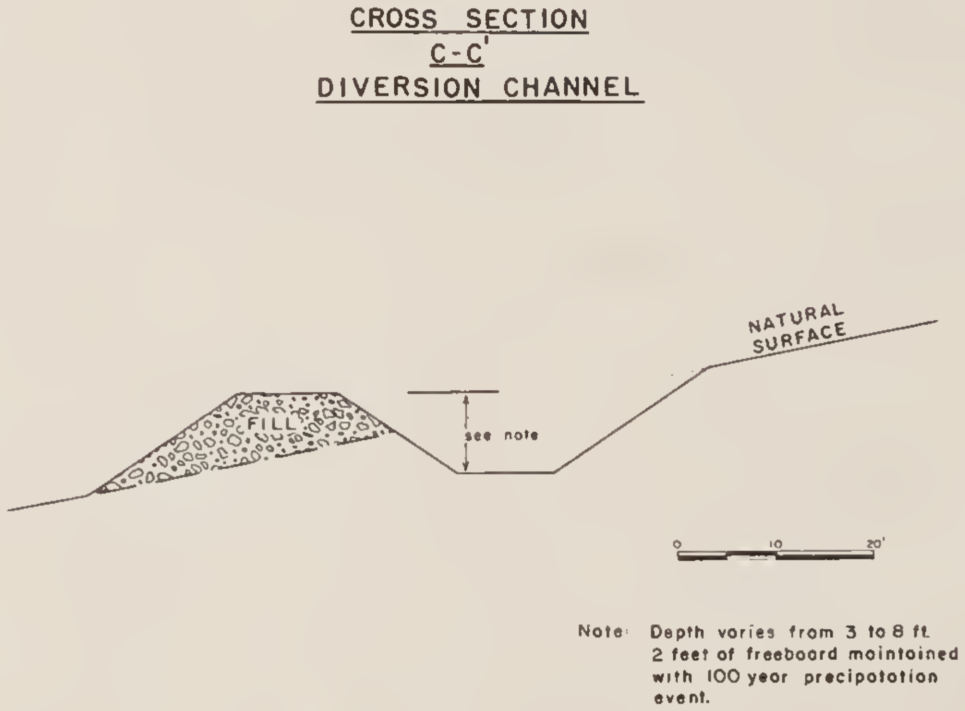
An instrumentation system designed to monitor embankment stability and drainage system performance would consist of large diameter cased sampling wells, called pizeometers, to be placed in the dam structure. Water levels would be measured monthly to insure that a depressed phreatic surface is being maintained.

Figure 6, Cross Sections of Proposed
Impoundment









Note: Depth varies from 3 to 8 ft.
2 feet of freeboard maintained
with 100 year precipitation
event.

PLACER AMEX INC.

GOLDEN SUNLIGHT PROJECT

TYPICAL
CROSS SECTIONS

WHITEHALL, MONTANA

date OCT, 1980 revised:	DWG NO. 804-12	drawn L.R.C. drafted:

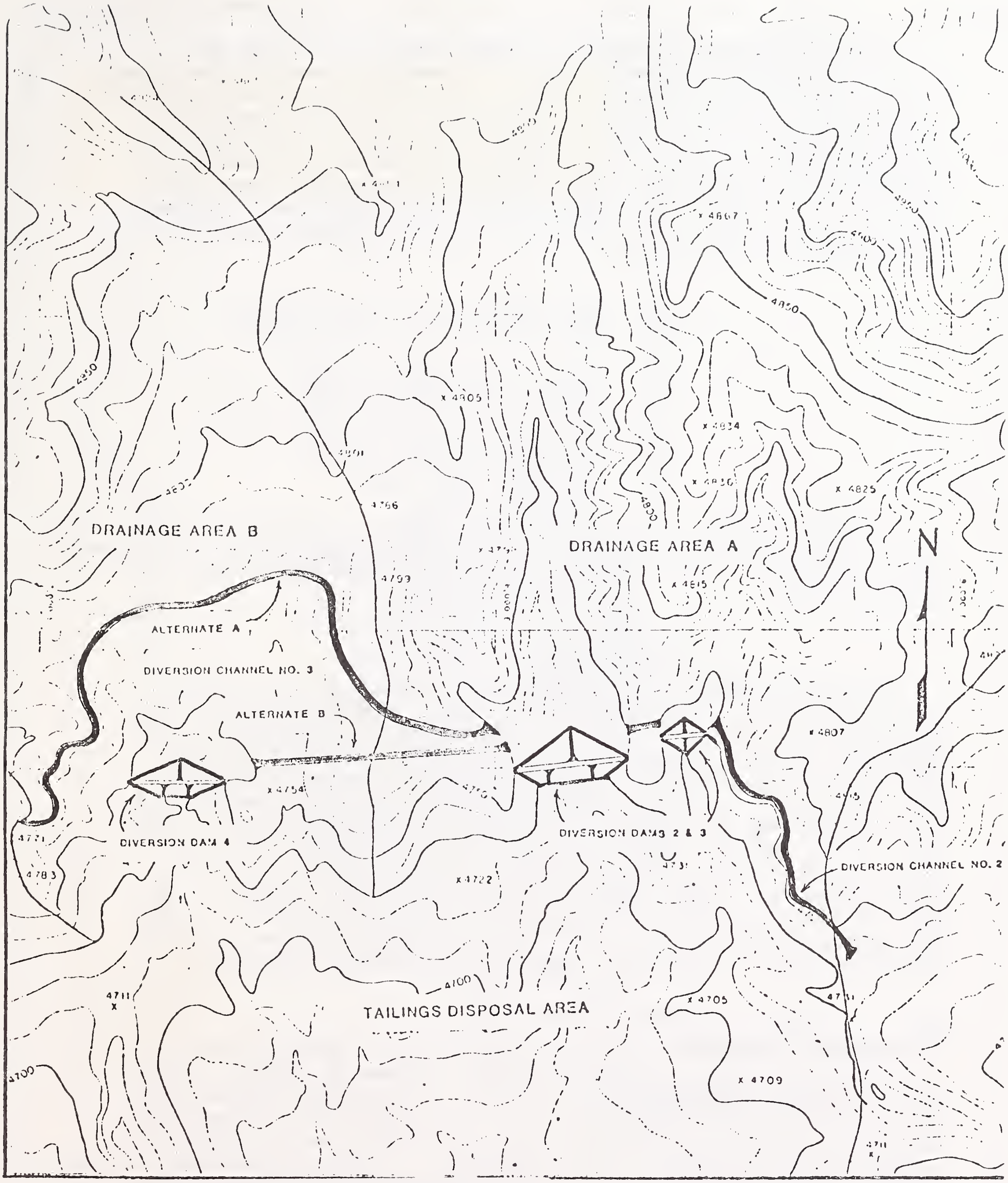


Figure 7. Surface Drainage Diversion

Graphical Scale:
0 200 400 600
Feet

Tailings Dam & Disposal Are
Golden Sunlight Project
Placer Amex Inc.
Jefferson County, Montana
SHB Job No. E80-89

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE

Five monitoring wells would be located down-gradient from the tailing impoundment as shown in figure 8. These wells would be monitored on a quarterly basis prior to discharge of tailing into the tailing area to establish baseline conditions. During the first year of operation they would be monitored monthly to establish groundwater conditions. If no contamination is observed, the monitoring frequency would revert to a quarterly basis for the remainder of the mining operation. Since the objective of this monitoring program is for early detection of adverse changes in groundwater conditions, the following indicator parameters are proposed to be monitored:

(1) water level
(2) water temperature (field and lab)
(3) pH
(4) cyanide concentration (mg/l)
(5) specific conductance (mhos)
(6) carbonate alkalinity (mg/l)
(7) bi-carbonate alkalinity (mg/l)
(8) free carbon dioxide (mg/l)
(9) dissolved oxygen (mg/l)

The cased and perforated monitor wells would be completed at least 20 feet below existing groundwater levels. If no groundwater is encountered, the cased borings would be terminated in the underlying impervious Bozeman horizon.

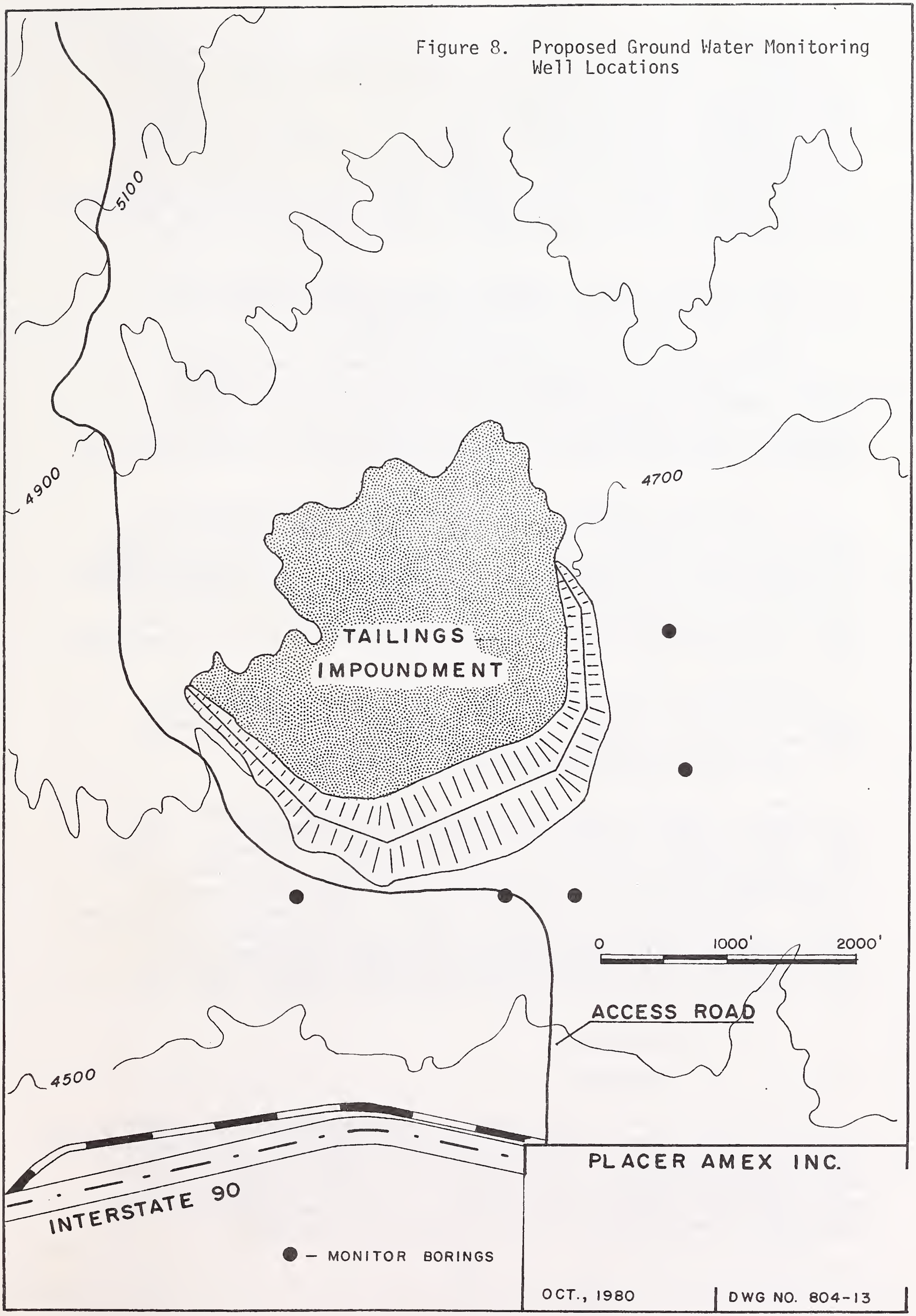
f. Mine Waste Dumps

During the estimated ten year mine life a total of 14.9 million cubic yards of mine waste rock would be removed from the open-pit and deposited near the mine. Four mine waste dumps are proposed to be built immediately north of the open pit mine site (figure 2). The smallest would begin at 5250 feet and rise the 5400 feet. The remaining three sites would rise bench-fashion from this point. The second bench would begin at 5250 feet and terminate at 5450. The third would begin at 5400 feet and rise to 5550 feet. The fourth and final proposed site would begin at 5500 feet and terminate at 5650 feet above sea level. The sloping faces of all dump sites would lie at the angle of repose. The total area to be covered by waste piles is expected to be less than 98 acres, of which 39 acres are within the presently bonded area. Heights and configuration of the waste dumps may vary with the topography.

g. Surface Drainage Control

Prior to the start of the mining operation the applicant proposes to construct a system of diversion channels and dams to control runoff from the two major drainageways in the area. The proposed system would be above the proposed tailing pond and is presented in two alternatives. The first alternative involves the use of diversion dike and channel to collect runoff and channel it to a second pair of diversion dams and channel. The second, and preferred alternative utilizes a diversion dam which would pond the water, channel it to a second pair of diversion dams and second diversion channel.

Figure 8. Proposed Ground Water Monitoring Well Locations



A schematic of the proposed drainage diversion design is presented in figure 7. The maximum flow in the channel between Areas B and A is estimated to be 450 cfs, while the combined outfall from the eastern drainage channel would be approximately 1100 cfs. Diversion dams would be constructed of compacted clayey materials, proposed to be obtained from excavation of the connecting channels. Connecting channels may be constructed below grade or in a cut/fill manner along existing contours (figure 9). The eastern outfall channel would require cut/fill construction along existing contours. Channel bottom widths would be 10 to 12 feet, and side slopes would be approximately 1:1 (horizontal to vertical).

Depending upon existing soil conditions, channel slopes would be minimized to reduce erosion potential. Riprap protection would be required at the entrance and exit of each channel.

Retention dams would be composed of homogeneous and compacted clayey fill (figure 6). Embankment slopes would be approximately 2.5:1. A small cutoff trench may be required to intercept highly permeable alluvium. Runoff from Area B would be diverted to the east into the impoundment of Diversion Dam No. 2; and subsequently pass through Diversion Channel No. 2.

Two alternative methods are proposed which would be designed to control surface drainage through Sunlight Gulch. The first alternative would involve a diversion structure which would intercept Area B drainage and would consist of a dike and channel constructed with a slight gradient (figure 7). The structure would be positioned to intercept spring and surface flow from the area of well no. 1 and the Bathtub Spring area (map). As presently conceived, the dike-channel would follow the topography and would appear rather sinuous in plan view.

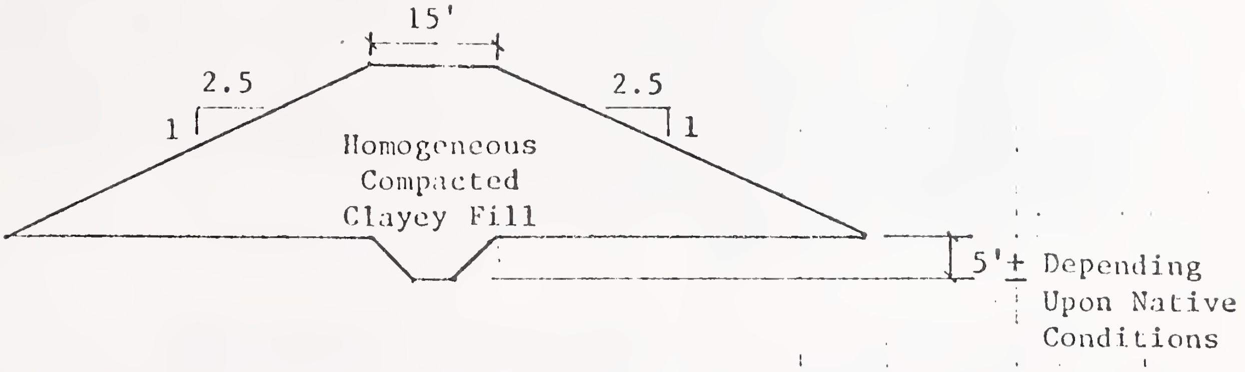
The second, and preferred alternative would be to construct an additional diversion dam at the lower end of area B. Overflow waters from the created impoundment would then be channeled to Diversion Dam No. 2 and subsequently through Diversion Channel No. 2.

From a 100 year, 24-hour duration storm, a maximum combined flow of approximately 1100 cfs would exit from Diversion Channel No. 2. This would cause a flow of approximately 2.5 feet deep in the natural drainage below the outlet of the channel. Water velocities in the drainage would be excessively high and would potentially cause unacceptable channel erosion. Construction of a series of rock-fill check dams in the drainage could be constructed to control channel velocities and reduce erosion. It is feasable to defer construction of the entire diversion system until cessation of operations. During operations, excess runoff would be contained by providing additional freeboard on the operational dam.

2. Ore Processing

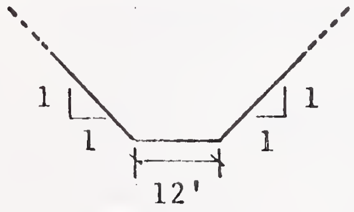
a. Crushing

Ore delivered from the mine would be dumped directly into a coarse ore bin, or onto a small 10,000 ton coarse ore stockpile. It is anticipated that the crushing circuit would operate on a 2 shift per day, 5 day per week schedule, similar to that planned for the mining operation. To provide continuity of crushing operations, a front end loader would feed the crushing circuit with ore from the coarse ore stockpile.



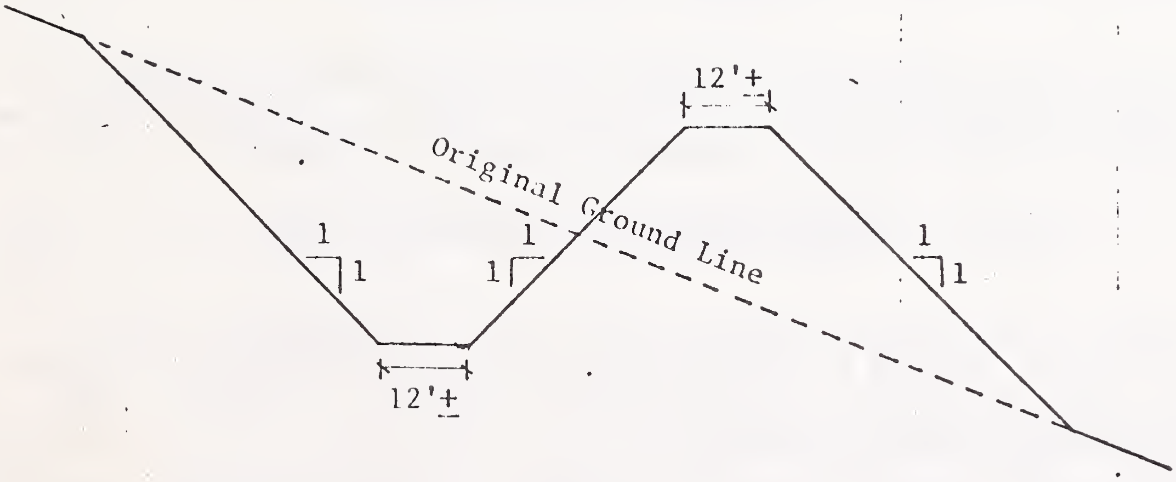
TYPICAL RETENTION DAM

TYPICAL DRAINAGE DIVERSION CUT



Depth of cut depends upon channel slope and flow volume

Side slopes depend upon local soil conditions



TYPICAL DRAINAGE DIVERSION CUT/FILL

Figure 9. Drainage Diversion Structure

Tailings Dam & Disposal Area
Golden Sunlight Project
Placer Amex Inc.
Jefferson County, Montana
SHB Job No. E80-89

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE

Ore from the bin would be fed to a jaw crusher at an average rate of 500 tons per hour. The jaw crusher product will be screened and the over-size material crushed in a 2-stage cone crushing circuit, which would produce the desired crushed product size. The final crushed product would be conveyed to the fine ore stockpile area. Crushed ore will be withdrawn from beneath the ore pile by feeders and conveyed to the wet grinding circuit in the mill building.

b. Milling

The mill circuit would operate on a 24 hour per day, 7 day per week basis. The average ore feed rate to the mill would be 208 tons per hour. A single rod mill/ball mill grinding circuit would be utilized to achieve the desired product size for the leach circuit. A cyclone classification circuit would return the oversize particles to the mill for additional grinding and would produce a final product that is essentially all finer than 35 mesh in size.

c. Reagent Leach & Value Recovery

After the addition of lime (5 pounds per ton of ore) and sodium cyanide (cyanobrik by DuPont Corporation, 1 pound per ton of ore), the aqueous slurry pulp from the grinding circuit (40 to 45 weight percent solids) would be subjected to conventional leaching in a series of mechanically agitated leach vessels. Compressed air would be introduced into the leach pulp to accelerate the leaching reactions. The leaching reaction for gold solubilization in cyanide solutions is indicated below and a simplified milling flowsheet is shown in figure 2.

The following equation represents the process which is thought to occur when gold-bearing ore is leached with cyanide. Because it represents a process, not an analysis, an attempt to balance the equation is not made.

$$4Au+8NaCN+O_2+H_2O \text{ -- } 4NaAu(CN)_2+4NaOH$$

After an appropriate pulp agitation time, the solubilized gold values would be removed by treatment with coarse particles of activated carbon. The tailing pulp would then be delivered by pipeline to the tailing pond area shown in figure 1.

Gold values would be removed from the activated carbon in a small reaction vessel and the gold recovered in an electrolytic cell. After thermal reactivation of the carbon, the carbon would be recycled back into the gold recovery circuit. The electrowon gold product would be refined in a small furnace and the "dore" poured into bars for shipment.

Placer Amex would operate a low grade gold recovery operation. The rate of recovery is presently estimated between 70 and 90 per cent.

d. Tailing Disposal

Approximately 40 acres would be utilized for initial tailing storage. This area would gradually expand during mine operations to a total area of 160 acres for ultimate tailing storage (figure 5).

Tailing material remaining after the leach process would be piped from the leach process to the tailing pond. The material would be spun in a centrifuge-type mechanism or hydrocyclone. The heavier particles would fall to the bottom of the cone-shaped mechanism. During the beginning phase of operation, the larger particles, or sands, would be used to construct the starter dike. That portion of the material which is clay particle size or smaller, tends to retain water and is referred to as the "slimes". They would be distributed in an area at least five hundred feet behind the starter dam.

e. Water Use

Fresh water would be drawn from a slough of the Jefferson River directly south of the proposed tailing pond. The pipeline would follow an existing water pipeline from Jefferson Slough to the south boundary of the north half of Section 32, then follow the proposed access road route to the millsite. Water would be then used as makeup for any deficiencies in the amount of decant water used in the processing of the ore. The fresh water pipeline would also supply the assay lab, office and sanitary facilities on the site. The rate of water use is estimated at about 700 gallons per minute with peaks of 1400 gallons per minute.

f. Sewage Disposal

The proposed sewage disposal system would consist of a septic tank and drainfield and would be installed slightly north and east of the proposed millsite. The system would be constructed with the consultation and approval of the Jefferson County sanitarian.

3. Reclamation Plan

a. Mine Site

The mine site lies in an area which was granted Operating Permit No. 00065, issued June 27, 1975 and is subject to the previously a pproved mine reclamation plan.

b. Mine Dumps

Placer Amex Inc. would recover topsoil materials from all areas proposed to be disturbed by mine dumps for reclamation purposes wherever practical. Topsoil depths are estimated at 3 to 6 inches on the gentle slopes below the mine area (see the Soil Conservation Service soil report Appendix C). To prevent wind and water erosion, stockpiled soil materials would be seeded with the following mixture which has been recommended by the Soil Conservation Service:

	*lbs. per Acre
Blue Bunch Wheatgrass	6
Crested Wheatgrass "Nordan"	2
Beardless Wheatgrass	6
Thickspike Wheatgrass	6
or	
Western Wheatgrass "Rosanna"	
Slender Wheatgrass	2
Yellow Sweet Clover	1
	23

*These are pure live seed recommendations (PLS).
The lb/Ac would be doubled if broadcast.

As waste piles are completed, slopes would be graded into the natural topography, matching natural slopes where possible. Following grading of these slopes, the distrubed areas would have a layer of topsoil, as available, placed upon them, and would be reseeded with the seed mixture above. Where necessary, contour benches would be cut across slopes to prevent erosion and allow revegetation to be accomplished. Seeding would be performed during the first appropriate season after final grading is completed. A cross section through the mine waste dumps showing original topography, mine waste dump surface, and final recontoured surface after reclamation is shown in figure 10.

c. Tailing Impoundment and Diversion System

Reclamation objectives would be to prevent contamination of water and soil through erosion of tailing by wind and water, and to accelerate the reestablishment of a self-sustaining ecosystem.

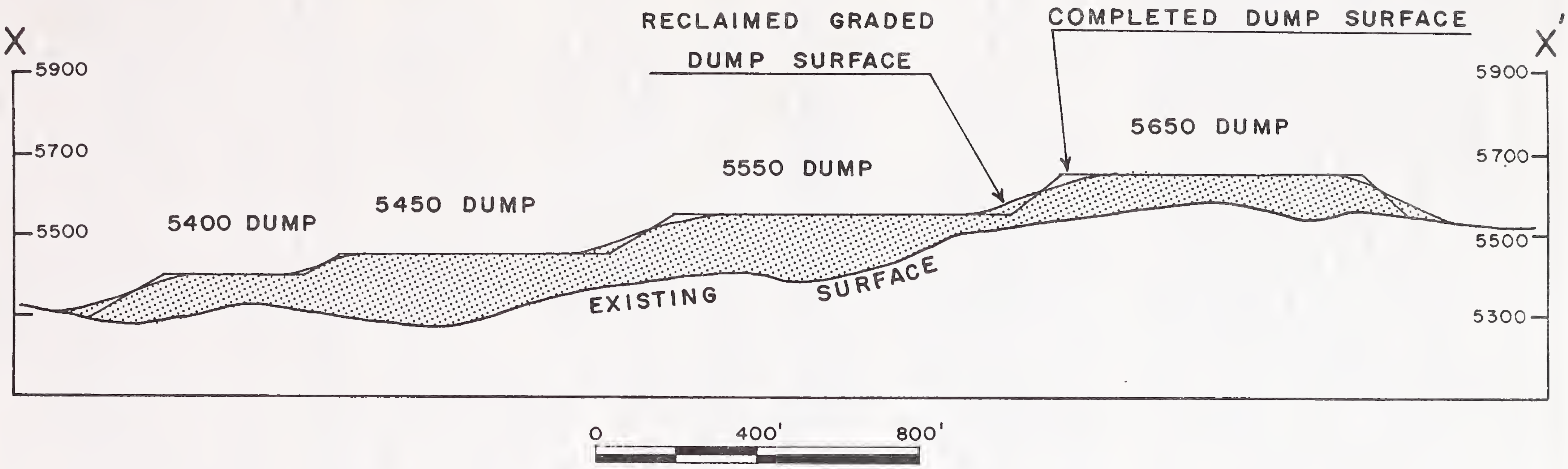
The existing topsoil conditions in the tailing pond area are described in a separate report by the Soil Conservation Service (Appendix C). The report indicates that an average 3 to 6 inches depth of topsoil exists in the proposed tailing impoundment area. Topsoil would be removed during the construction phase and stockpiled in the areas noted in figure 1. During storage, topsoil would be contoured and revegetated with a seed mixture approved by the Soil Conservation Service, to prevent erosion. During final reclamation, the salvaged topsoil would be redistributed over the tailing dam and impoundment area and revegetated with the seed mixture presented above.

Although specific reclamation configurations and seed mixtures are indicated, it is proposed that a reclamation test plot be established near the tailing impoundment area during the early years of operation. This test plot would be constructed of mill tailings on an area that is large enough to permit testing of a number of reclamation procedures. These test procedures would evaluate different seed mixtures, fertilizer applications, mulching procedures, and topsoil application methods. The test program would be initiated in the second year of operation and would continue throughout the life of the mine. It would be a cooperative program with the Reclamation Division of the Department of State Lands, the Soil Conservation Service and other consultants. The results of this program would be evaluated on an annual basis and used to produce the most acceptable method of reclaiming the tailing pond.

Figure 6 indicates a typical cross section through the final tailing impoundment area and the diversion channel above the area. Reclamation of the downstream sections of the tailing dam would be initiated during the operational phase of the project. As the dam structure is raised during the operation, the lower downstream dam face would be revegetated with grasses and perhaps with dry climate species of shrubs or trees.

Following reclamation and abandonment, the surface water diversion structures would be left intact to minimize the surface water inflow to the tailing area. These structures would be designed to minimize erosion at entrance and discharge points. It would also be possible during final reclamation to construct additional diversion channels to further reduce the surface drainage from reaching the tailing area. Thus, the drainage area above the reclaimed tailing pond can be reduced to about 120 acres which would potentially eliminate the possibility of surface

Figure 10. Waste Dump Cross Section



PLACER AMEX INC.

GOLDEN SUNLIGHT PROJECT
SECTION X-X'
LOWER WASTE DUMP

OCT., 1980
DWG NO. 804-15

water discharges from the tailing impoundment during a possible 100 year precipitation event.

After operations have ceased, the tailing would continue to dry by surface evaporation and drainage through the under-drain system. Drainage water could be returned to the tailing area and evaporated by sprinkling over the surface of the tailing. To minimize possible water inflow and recharge to the tailing area, the spring above the tailing (which provides most of the inflow into the perched water system in Sunlight Gulch beneath the tailing area) can be diverted to the area east of the tailing pond. Precipitation falling on the revegetated tailing surface would be utilized by vegetation or lost by evaporation. Therefore, upon final reclamation, the tailing system would be isolated from both surface and ground water flows. To further ensure that stagnant ponding at the low point of the tailing pond does not occur prior to revegetation, the tailings would be graded to a very gentle slope to increase the potential evaporation surface.

d. Millsite

Upon completion of the mining operations, when no potentially economic ore remains, the milling complex would be dismantled and removed from the site and the area contoured and revegetated.

e. Roads and Utility Corridors

Roads would have berms rounded off, graded into existing topography, and would be ripped upon abandonment. Sloping sections of roadbed would be water barred to prevent erosion, and all disturbed areas reseeded with a seed mixture recommended by the U. S. Soil Conservation Service.

Revegetation would be accomplished in the first appropriate season after road reclamation is completed.

Reclamation of disturbed areas would involve removal of surface utility facilities, and recontouring and grading of the disturbed areas to match existing topography. All disturbed utility areas would be reseeded in the first appropriate season after reclamation is completed.

4. Employment Requirements

Total employment at the Golden Sunlight Mine is expected to be approximately 125 persons, including administrative, supervisory, and operation personnel. It is anticipated that a majority of these employees would be employed from within the surrounding communities.

All work schedules would involve a 52 week per year operational basis. Mining activities would be performed on a 2 shift per day-5 day per week schedule, while the milling activities would be conducted on a continuous 3 shift per day-7 day per week schedule.

Construction activities would take place in the 12 months preceeding the operational phase. During the one-year construction period, the total work force would peak at approximately 200 employees for 3-4 months and be less than 100 employees during both the initial construction period and the period near construction completion. It should also be noted that, depending upon the construction contractor, and limitations and the availability of skilled craftsmen, a number of the construction employees would probably be local employees of sub-contractors.

II. Description of the Existing Environment and Impact of Proposals

A. The Physical Environment

1. Location and Description of the Area

The proposed mine permit area is located in Jefferson County, approximately four miles east of the community of Whitehall, Montana. The area is north of the Jefferson River, near the southeastern border of an area of granitic upwelling and intrusion extending from the southern edge of the Helena valley to the northern edge of the Jefferson valley near Whitehall, and west to Butte, Montana. Geologically the area is known as the Boulder Batholith.

2. Topography

The proposed mine site lies within the southeastern part of the Northern Rocky Mountains physiographic province. The province is characterized by deeply dissected mountain uplands separated by extensive benchlands. The site lies at the northern flank of the east-west trending Three Forks intermountain basin and is bounded on the northwest by the southern tip of Bull Mountain. The area is bounded on the south by the floodplain of the Jefferson River.

3. Climate

The climate of the proposed mine site is typical of southwestern Montana where local ranges of the Rocky Mountains greatly influence climatic conditions, and is classified as a semi-arid intermountain climate. Winters in general are cold with occasional mild periods which melt snow accumulations in the valleys. Summers are characterized by wide daily temperature variations, abundant sunshine, low relative humidity, and occasional thundershowers. Annual precipitation ranges between 12 and 20 inches with peaks occurring in May and June. A smaller peak amount of moisture usually occurs in September.

The growing season is short, between 90 and 120 days. Temperatures range from minus 40 degrees fahrenheit in winter to 100 degrees fahrenheit in the summer. Freezing temperatures can occur as late as mid-June and as early as September. Heaviest precipitation occurs on the western or windward slopes of the mountain.

4. Geology

The following discussion is based on a report entitled: Interim Geotechnical Report, preliminary site evaluation, Golden Sunlight Project, Placer Amex Inc. Jefferson County, Montana.

Regionally, the Whitehall area is near the junction of three geologic structural subdivisions; the Eastern Rocky Mountain Structural Province, Beltain Geosynclinal Province, and the Boulder batholith.

Exposed rock ranges from Late Pre-Cambrian unmetamorphosed sedimentary rock to Holocene stream channel deposits of unconsolidated alluvium. Five geologic units are present within the study area. These units are, from oldest to youngest, the Pre-Cambrian Lahood Formation (Alexander

1955), the Tertiary Bozeman Group (Robinson 1963), Quaternary channel deposits of the Jefferson River. Locally, the LaHood Formation is exposed along the south flank of Bull Mountain, with a southeast-trending projection extending to the western border of the Section 32 tailings disposal site. The LaHood Formation consists of highly folded, brown to gray micaceous silt-stone interbedded with fine-grained, thinly laminated to thickly bedded, sandstone and hardened sandstone. It has been reported (Alexander 1955) that this formation regionally obtains a thickness of 2,700 feet.

Two formations with the Bozeman Group are present within the study area, the Climbing Arrow and Dunbar Formations. The Climbing Arrow Formation underlies the proposed tailings disposal site and is sporadically exposed along the flanks of the Sunlight Gulch. The formation consists of light green to olive-brown claystone and siltstone which is thickly-bedded and weakly hardened, interbedded with laterally discontinuous lenses of yellowish to greenish-brown coarse-grained sandstone. This sequence is overlain by grayish-brown conglomerate of subrounded gravel and small cobbles cemented with a fine-grained matrix of silty clay.

Overlying the Climbing Arrow Formation and exposed as prominent ledges northeast of the proposed tailings disposal site, the Dunbar Formation is present. This formation consists of light brown, weakly hardened sandy siltstone interbedded with silty sandstone. The Quaternary rock units include fluvial silty sand and gravel deposits which colese with wind-deposited silt. These units cap the Climbing Arrow Formation and form ridges within the benchlands below the flank of Bull Mountain. Thicknesses of up to 64 feet have been measured in the area.

Extensive Quaternary sand, gravel and cobble deposits occupy the flat-lying floodplain of the Jefferson River. These deposits contain thin laterally continuous, lenses of silty clay.

A literature search was made by Sargent, Hauskins, and Beckwith, 1980, concerning potentially active geological fault systems which might influence the permit area.

Three fault systems, the Willow Creek, the Lombard and the Madison were identified.

After a review of the existing data, the report concluded that the Willow Creek system is not active and would not affect the design of the tailing pond. The Madison fault system which lies seventy five miles to the south, and the Lombard fault system which is seventy five miles to the northeast were considered potentially active because they have exhibited movement in the last 10,000 to 35,000 years.

Further discussion of the fault systems, and the consideration of seismic risk and major event reoccurrence is contained in Appendix D.

5. Air Quality

Sources of which would affect the existing air quality of the proposed mining project area are listed below:

a) An open-pit gold mine with the necessary extraction facilities to produce 1,750,000 tons of gold ore and 2,275,000 tons of waste annually.

b) Areas of disturbance, ore handling facilities and associated equipment:

1. Open pit - 63 acres
2. Tailings Pond - 160 acres
3. Millsite - 24 acres
4. Dumps - 98 acres
5. Haul Roads - 48 acres
6. Primary Crusher
7. Fine Crushing Area
8. Transfer Tower
9. Fine Ore Reclaim
10. Coarse Ore Bin Dumping
11. Fine Ore Stock Transfer
12. Fine Ore Stockpile
13. Primary Coarse Ore Feeder

c) Necassary Auxiliaries:

Blasthole rigs, front-end loaders, shovels, dozers, scrapers, graders, trucks, cranes, power facilities, storage and equipment housing, etc.

Additional sources of pollution which affect the existing air quality of the proposed mining project area are listed below:

1) Emission sources in the urbanized area of Whitehall;
2) Interstate Highway 91 one half mile south of the site, and state highway 281, two miles east of the site;
3) Open burning;
4) Unpaved streets and roads;
5) Soils devoid of vegetation.

The primary impact on air quality from the proposed mining operations would be an increase in suspended particulates. The main source of the particulates would arise during mining and haul road activities. Additional particulates would arise from the ore milling process, overburden, and soils exposed during mining before reclamation would be completed. Air inversions which occur in the area, particularly during the autumn and winter months, have the potential to trap the increased particulate matter from the mine and related activities, thereby reducing visibility in the area and contributing further to the adverse effects on the aesthetics of the airshed during these periods.

During dry, windy periods, parts of the tailing impoundment surface would probably be dry enough to produce airborne particulates. Any such particulates would be composed of the fine ground tailing. The Montana Metal Mine Reclamation Act requires that proper precautions must be conducted concurrently with the construction and operation of the proposed project to assure that wind erosion on exposed cuts, tailings, or spoil disposal areas would not become a public nuisance or detriment to local flora and fauna.

Appendix A contains a Preliminary Environmental Review prepared by the Air Quality Bureau (AQB) of the Department of Health and Environmental Sciences for the Air Quality Permit application by Placer Amex. Approval of the permit was granted by the AQB November 13, 1980, and is contingent upon several conditions as outlined in the permit. Adherence to the permit conditions during the operations would significantly reduce the potential for adverse air quality impacts.

The estimated emissions associated with the mining activity are shown in Table below entitled "Emission Estimates Tons/Year."

EMISSION ESTIMATES Tons/Year

	Placer Amex		Air Quality Bureau	
	Uncontrolled	Controlled	Uncontrolled	Controlled
Truck Dumping	4.1	4.1	4.1	4.1
Loader Dumping	10.6	10.6	10.6	10.6
Primary Crushing	78.6(1)	32.7	78.6	32.7
Fine Ore Pile Feed Belt	17.5(1)	11.7	17.5	11.7
Fine Ore Pile	0.2	0.2	0.2	0.2
Fine Ore Reclaim	17.6(1)	12.2	26.3	12.2
Carbon Regeneration	6.6(2)	0.9	6.6	0.9
Refining Furnace	1.9(2)	0.4	1.9	0.4
Haul Roads	29.9(3)	6.0(4)	29.9	6.0
Drilling	1.1	0.7	1.1	0.7
Blasting	2.2	1.5	2.2	1.5
Ore loading	7.9	5.3	7.9	5.3
Waste loading	6.9	6.9	6.9	6.9
Waste loading	5.3	5.3	5.3	5.3
Road Maintenance	1.9	1.9	1.9	1.9
Coarse Ore stockpile	0.14	0.14	0.14	0.14
Access Road	15.4	5.4	15.4	5.4
Total	207.84	105.94	216.54	105.94

6. Soils

A soils survey was conducted by the Whitehall field office of the Soil Conservation Service for the proposed permit area in November, 1980. The survey was made in accordance with the Department of State Lands' reclamation guidelines.

The summary identified the soils of the area as primarily decomposed granite.

The soil types are deep, well drained to excessively drained and are moderately dark in color. They have thin (3-7") dark colored loam or gritty loam topsoil, and some have a distinct to prominent zone of lime accumulation. One soil unit was determined to be very dry and not possessing zones of accumulation. Soil textures occur as loam or sandy silt loam with variable to extreme amounts of granitic gravels.

Soil types are fairly consistant throughout the mining area with expected areas deeper topsoil in the bottoms of the undisturbed areas and thinner topsoil on the ridges.

The potential environmental impacts to the soils of the proposed permit area include (1) loss of productivity because of direct soil disturbance, loss of soil structure and soil compaction during mining and associated disturbance, (2) soil erosion from areas during the above activities that have none or inadequate soil erosion prevention measures applied on steep slopes.

Soil disturbance as a result of mining activities would cause some decline in soil productivity, and some soil losses would occur. Soil biological activity and organic matter would be reduced and soil structure lost. This would probably cause minor changes in soil productivity and infiltration rates. However, basic soil properties necessary to sustain long-term productivity would not be substantially affected.

The presence of significant areas of steep slopes within the area proposed to be disturbed by the mining operation will increase the risk for soil erosion. Mitigation measures will be necessary to prevent significant soil erosion during periods of excessive precipitation.

7. Hydrology

a. Surface Water

(1) Onsite

The proposed mining project and tailing impoundment are contained within a watershed of about 1,065 acres which comprises five distinct ephemeral drainages. The report by Sergent, Hauskins, and Beckwith (1980) detailed the anticipated maximum drainage volume for each of the acres in the event the information is presented below:

Drainage Area	Acreage	Rate of Peak Inflow to Waste Impoundment	Maximum Volume of Precipitation for 100 yr.-24 hr. Storm
A	500	675 cfs	116.7 acre-feet
B	224	403	52.3
C	96	175	22.4
D	117		
Tailings Impoundment	128		57.2

The above figures are based upon an expected 100 year-24 hour precipitation of 2.8 inches, 100 year-6 hour precipitation of 1.6 inches (Miller, 1973), a maximum intensity of 1.00 inch per hour (Frevert, 1955), and a coefficient of storage and infiltration of 0.6.

Surface runoff generally seeps into the substreate before it reaches the Jefferson River, and becomes part of the local groundwater systems' contribution to the adjacent Jefferson River valley groundwater system.

(2) Jefferson River

The Jefferson River begins approximately twenty five miles southwest of Whitehall at the confluence of the Beaverhead and Ruby Rivers. It flows north and east through the lowlands in a drainage formed by the Highland mountains to the west and the Tobacco Roots on the south. The Jefferson flows east approximately one and one half miles south of the proposed permit area. It is joined by the Boulder River about five miles east of Whitehall near Cardwell, Montana. The river then proceeds east and joins with the Madison and Gallatin Rivers near the community of Three Forks to form the Missouri River.

Both geologic history and weather patterns affect the formation and evolution of the Jefferson River. Intense summer thundershower activity tends to wash mobile granitic soils into the system. As a consequence, streams in the area exhibit sandy bottoms and carry heavy sediment loads during periods of runoff.

The Jefferson River near Whitehall is a mature stream. It winds its way through alluvial lowlands and many oxbows are evident. Numerous oxbows have become cut off from the river and a system of sloughs, many of which are dry, have formed.

Slaughterhouse slough west of Whitehall is about five miles southwest of the permit area, and Jefferson slough approximately three fourths of a mile south of the permit area, both carry water and eventually connect with the Boulder River about a mile upstream from its confluence with the Jefferson River.

A system of shunts was constructed to service irrigation needs of the area. One shunt operates to divert water from the Jefferson River to Slaughterhouse slough when the volume of the Jefferson River reaches 3000 cfs. A second shunt diverts water from Slaughterhouse slough to Jefferson slough. Seasonal contribution to the system occurs from Whitetail and Pipestone Creeks. At Whitehall, the city sewage treatment plant releases its effluent into Jefferson slough.

Dewatering is a severe problem in the Jefferson River system. Water is removed for irrigation from the Beaverhead River, a major headwater tributary, as well as throughout the Jefferson River drainage. Many years the flow of the Jefferson River is too low to operate the shunt between the river and Slaughterhouse slough. One irrigator has repeatedly cut down the channel entrance to the shunt in an attempt to enhance the reduced streamflow. This further dewaters the system and reduces available fish habitat during low water periods (see Section B.3.).

Continental Sand and Gravel mines material from the old riverbed near Jefferson slough. Several of the abandoned pits have filled with water and contribute to the slough system.

Water quality data for the Jefferson River indicate a rather wide yearly variation in temperature, an alkaline pH, medium hardness and alkalinity and good buffering capacity. Calcium bicarbonate is the dominant alkaline component, and carbonate levels periodically occur in low amounts.

Maximum recorded nitrate level is 1.7 mg/l, far below the Environmental Protection Agency (EPA) drinking water standard of 10 mg/l.

Measurements of total phosphate are variable with a range of less than 0.01 to 0.164 mg/l reported. The latter measurement was taken near Cardwell in January 1978 and is above the EPA standard of 0.1 mg/l.

Sources of water pollution in the Jefferson River valley include farming related runoff and irrigation return flows. Effluent from the Whitehall sewage treatment facility flows into the Jefferson Slough, then to the Boulder River. However there may be undergravel continuity between the Jefferson River Slough and the Jefferson River.

(3) The Boulder River

Available water quality data for the Boulder River indicate the river is cold, neutral to mildly alkaline in pH, low in alkalinity and chemically unbuffered. Data on nitrogen and phosphate levels indicate these substances exist at very low levels in the system.

The upper Boulder River valley has a long history of mining. As a result, many small tributaries flow through abandoned mine tailings, distributing the material throughout the streamshed.

Results of studies through Monana State University at Bozeman, and the Soil Conservation Service indicate heavy metals from the old tailings piles are present in the system. They also indicate that heavy metals continue to be leached into the system by geologic processes, however an understanding of the total effects of these materials on the system is presently incomplete.

Because of numerous diversions for purposes of irrigation, the lower end of the Boulder River experiences severe dewatering during periods of low flow in the latter part of the season.

b. Ground Water

Two distinct groundwater regimes exist within the study area; the regional system of the Jefferson River floodplain, and a localized shallow system encompassing the springs and perched groundwaters of Sunlight Gulch. The localized system of Sunlight Gulch includes a spring line which is present immediately north of the proposed disposal area and perched groundwater flow present in a buried channel subparallel to the topographic expression of Sunlight Gulch. One spring is above the proposed tailing area and just west of the existing road (figure 1). The other lies in the same general area, but is just east of the road. It presently is routed through a two-inch pipe beneath the existing road and forms a small stockwatering pond on the west side of the existing road. Perched groundwater appears to migrate to the spring system within unconsolidated alluvium and colluvium overlying the Bozeman Group. After flowing on the surface for a short distance, waters seep to a buried channel cut in the Climbing Arrow Formation and subsequently filled with alluvium of moderate hydraulic conductivity. Depth to unconfined water within the disposal area is about 50 to 60 feet and restricted to a narrow corridor in the lower reaches of the drainage. All this water appears to be perched on the underlying impermeable Climbing Arrow Formation.

Reliable data are scarce, however a single water sample taken in August, 1980 and analyzed by the Montana Bureau of Mines and Geology in Butte indicate water chemistries of a nature different from those usually found in small mountain valleys, whose primary water source is snowfall and rain. The sample was taken from well number 1 (figure 1), and was acidic. A laboratory pH of 5.48 was recorded. An unusually high amount of magnesium was measured, indicating magnesium sulfate as the dominant alkaline component, rather than calcium carbonate. Elevated levels of sulfate were reported as were sodium, potasium, silica, and chloride. Specific conductivity was reported at 735.8 micromohs. These chemistries may reflect seepage of precipitation through localized intensive mineralization which has occurred in the area. Known hot springs occur twenty miles north of the project site. Hot water influence is possible but improbable. Available groundwater information is presented in Appendix B.

Several residences are located on the floodplain of the Jefferson River, south of the proposed mine area. Depth of domestic well in the area range in depth from 35 to 62 feet.

c. Impact

Analysis has shown that the normal operation of the proposed facilities would not result in a significant adverse impact to the areas existing subsurface and surface water resources. The major potentials for impact to the existing water resources of the area as a result of the proposed project would include (1) seepage of chemically contaminated waters from the tailing impoundment into the adjacent ground water system and (2) a massive failure of the proposed tailing containment system resulting in a surface flow of tailings that could potentially reach the Jefferson Slough.

The following site-specific analysis presents information related to the operational phase of the proposed project. While the construction phase of the project would increase the potential for erosion related sediment and oil and grease contamination, the general lack of surface water within the project area precludes its detailed consideration.

(1) Mine and Dump Sites

The proposed mine site would ultimately involve a 63 acre open-pit mine. Some precipitation or surface water trapped in the open-pit may infiltrate and contribute to the groundwater system; precipitation that would ordinarily be surface flows. Although there is no detailed technical information describing groundwater movement in the proposed mining area, it is assumed that most of the water trapped in the pit would seep into the fractured bedrock and become part of the regional groundwater system of the area. The amount of water trapped would be insignificant compared to the regional groundwater system and any impacts to groundwater quality probably would be undetectable. The infiltration of surface water to the groundwater system would be very localized and should not cause any measurable change in groundwater quality.

In addition, approximately 98 acres would be consumed by the proposed mine dump sites (figures 2 and 10). Of concern when collectively considering the mine and dump sites is the potential for the production of acid mine drainage. Ore materials from the proposed mine contain sulphur and sulphide minerals can be oxidized microbiologically to surfuric acid and soluble metal sulfate salts. This phenomenon can result in a potential water pollution hazard if the amount of sulfuric acid which the bacteria produce exceeds the neutralizing capability of the host rock. If acidic drainage water occurs, the microbiological attack on sulphur and sulfides contained in the sample, as well as the microbiologically produced acid, could solubilize heavy metals which could be toxic to aquatic flora and fauna in the area, if they were allowed to enter receiving waters.

Placer Amex Inc. has supplied the Department with the results of an "acid production potential test" conducted by B. C. Research, Vancouver, British Columbia for the Golden Sunlight ore, the results of the study confirmed the potential for the ore to be an acid "producer" as compared to an acid "consumer". The test, however, is conducted on the finely ground ore, similar to the tailing, and not on the mine-run size ore. The report contains the following caution regarding interpretation of the data for larger size materials:

> *A degree of caution must be exercised in extrapolating the test results of coarser samples. Both the available surface area and the amount of exposed sulphides will be reduced leading to a reduction in both the acid consumption and the potential acid production. Experience has shown that generally relatively more gangue than sulphides is exposed at the larger particle sizes although this may not always be the case.*

Based upon the fact that previous historic mining activity and waste dump development on the project area have not resulted in the occurence of acid mine drainage, and the general lack of a water discharge from existing underground workings at the site, it is reasonable to conclude that the potential for acid mine drainage as a result of the proposed project is minimal.

Another question that must be addressed is the possibility of encountering a body of toxic water in the mine. The reaction and dissolution of some minerals by water can yield waters that are toxic and could possibly be contained in a hydraulically isolated block. The general geology of the area indicates that rock fractures are the dominant paths for water transport and the rock type is consistent throughout the area. An independent body of water with a poor or no hydraulic connection to the remainder of the rock system would be an unusual system. Encountering a body of water in a mine having a substantially different quality than water in the remainder of the mine also is unusual. There is no evidence to suggest that a body or bodies of toxic water exist in this mine. Although the probability of the occurrence of a body of toxic water cannot be assumed to be zero, the probability of this occurrence seems to be remote and should be considered a very unlikely problem.

(2) Mill Site

There are no discharges proposed to natural surface waters from any of the mill facilities, therefore, there will be no impact on surface water quantity or quality resulting from operation of the facilities.

During transport of reagents used in the milling process it is possible that a spill could occur. The significance of a reagent spill would reflect the amount of reagent involved, location of the spill, eliminate conditions at the time of the spill or before cleanup can occur, and the nature of the spill itself, cumulative or sudden. The general lack of surface water along the haul route and the ephemeral nature of the drainages crossed further reduce the threat for adverse impacts should a spill occur.

(3) Tailing Line

The integrity of the tailings and return decant water lines is a concern in view of the fact that a line failure may cause water and/or tailings to enter the ephemeral drainages. In the event of a failure of either the gravity tailing line or the return line, there would be a loss of chemically contaminated water into the watershed and a water quality problem could occur. Tailing slurry from the pipeline would be deposited on the ground and could eventually reach adjacent surface water systems.

Line failure could basically occur as a leak or break in the line or a plugging of a drop box or boxes. Chemical composition of the tailing slurry, as indicated in test milling analysis results submitted by Placer Amex,Appendix F, would be characterized by high levels of alkalinity, carbonate, chlorides, cyanide, hydroxides, dissolved solids, sulfates, calcium, and a high pH.

Of major concern should a spill occur to surface drainage systems would be the cyanide and metallocyanide complexes contained in the solution. Cyanide, to remain as cyanide in the solution, requires a pH of 10 or greater. Below a pH level of 10 the cyanide is converted to cyanate, considered to be about 1/1000th as toxic as cyanide. Peter Doudoroff (1976) in his EPA report titled "Toxicity to Fish of Cyanides and Related Compounds" concludes the following regarding the toxicity of cyanate:

> *The cyanate, CNO, ion, which is a product of oxidation of cyanide by alkaline chlorination, a widely used method of wastewater treatment for cyanide removal, also appears to be relatively but not entirely harmless to fish. . . Enough information about the (past) experiments performed and the results on which these values are based has not been included by the authors, however, in the cites publications. Cyanates may persist in water for a long time but are subject to hydrolysis yielding ammonium and carbonate ions.*

In the event of a spill it is doubtful that the solution would remain above a pH of 10 for a significant distance beyond the discharge. When cyanide is converted to cyanate, some free cyanide gas (HCN) is released. This reaction would not be considered hazardous, however, because the proposed pipeline would be located in an open area with maximum ventilation.

Of perhaps greater concern than the cyanide in the solution of any spill is the occurrence of the metallocyanide complexes in the waters. These components of the process water solution, once thought to be relatively stable, and harmless as a result, have recently undergone further research that has indicated otherwise. Doudoroff (1976) states that "results of experiments on the toxicity of the complex cyanides have been often misinterpreted in published literature, largely because of insufficient understanding of the complicated chemistry of dilute solutions of these compounds." He further concludes that "unfortunately, most of the pertinent literature has to do with lethal effects and tolerance limits, and the available information on sublethal effects of cyanides is scanty. Knowledge of the tolerance limits alone obviously is not a sufficient basis for any definite conclusions as to limits of entirely harmless concentrations of toxicants."

Many earlier researches of cyanide complex toxicity failed to consider adequately, the large differences in stability of the different complexes and the important influence of pH on the dissociation of the complexes in dilute solutions. Doudoroff (1976) states that " the degree of dissociation and toxicity of a metallocyanide complex can vary greatly with the pH of the water." Doudoroff (1956), experimenting with fathead minnows, Pimephales promelas, found the toxicity of the zinc-cyanide and cadmium-cyanide complexes to be very great. He concluded that this high toxicity was ascribable mostly in liberation of virtually all of the cyanide (i.e., nearly total dissociation of the complexes) in very dilute solutions. Complexation of cyanide with nickel, copper, and iron greatly reduced its toxicity, but the toxicity of the nickelocyanide complex was found to vary strikingly with the pH of the solutions and to be quite pronounced (not very much less than that of NaCN) at pH levels as low as 7.5-6.7. The findings of Doudoroff, Leduc, and Schneider (1966) did not show the toxicity of the metallocyanide complex ions themselves to be always slight, or the contribution of these ions and the more toxic heavy metal cations deriving from their dissociation to the toxicity of solutions of complex cyanides to be always negligible. The experimental results, however, did lend strong support to the supposition that the industrial waste waters is usually due predominantly to the presence of free cyanide liberated by dissociation or decomposition of the complexes in the form of accurately measurable, molecular HCN.

The relation of pH levels to the dissociation and toxicity of the metallocyanide complexes to fish and other aquatic life is very important. The influence of snowmelt in the area of the proposed facilities could be reasonably expected to seasonally lower the pH levels of the ephemeral surface waters to 6.5 or lower. Should a spill of the process waters containing the metallocyanide complexes occur at such a time, there would be a increased potential for an adverse toxic impact to any aquatic life found in the waters receiving the spill or discharge. It must be remembered, however, that free cyanide in water converts to the much less harmful cyanate within a short distance of its introduction. The lack of any perennial surface waters in close proximity of the proposed facilities, and the location of the facilities in highly visible areas, however should result in a minimal potential for adverse affects to the area's water resources if cleanup efforts by Placer Amex personnel are prompt.

(4) Water Use Line

Installation of the proposed water use line from the mill site to the Jefferson Slough (figure 1) is not anticipated to adversely affect the area's water resources. The water use has been previously appropriated, and reclamation of pipeline disturbance is planned to immediately follow its installation. It is possible, however, that during periods of low water availability caused by drought, or ice conditions, availability of water from the slough for makeup water use at the mill could be limited. In addition, increased diversion of the area's water for irrigation purposes in the areas adjacent the project could in the future seasonally limit water availability at the mill.

(5) Tailing Impoundment

Of primary concern regarding the installation and operation of the proposed tailing impoundment are 1) the possible impact of the proposed system upon the local surface and groundwater systems, and 2) the integrity of the structure in relation to potential geologic or seismic hazards. In response to these concerns, Placer Amex Inc. provided a geotechnical study of the tailing impoundment area by Sergent, Hauskins and Beckwith, Consulting Geotechnical engineers. The scope of the study included a geologic and hydrologic literature and data search, ground reconnaissance of the prospective site area, and a preliminary field exploration program which included test drilling and pits, pump testing of an existing well, and installation of open well piezometers. Much of the following discussion is based upon information obtained from the study.

(a) Seepage

Seepage of chemically contaminated waters from the tailing impoundment into the area's groundwater system is a potential impact of great concern. Ground water in the immediately adjacent areas of the Jefferson River valley is shallow and used for both domestic and agricultural purposes.

A large portion of the impoundment area is underlain by a higher variable thickness of alluvium which is, in turn, underlain by Bozeman Group claystones, siltstones, and sandstones. The remaining portion of the impoundment, and along its western boundary, is underlain by the LaHood Formation. The reader is referred to the previous discussion of geology for a more detailed presentation of the materials subsurface to the proposed tailing impoundment.

For seepage containment purposes, a positive cutoff to the essentially impervious Bozeman Group is necessary. In the deeper area of the channel, Placer Amex Inc. proposes to use a bentonite slurry cutoff design (see Chapter One). The precedent for the use of a slurry cutoff of seepage containment is discussed in detail in the report by Sergent, Hauskins, and Beckwith. In addition, a blanket drain beneath the dam structure, and finger drains in conjunction with periferal clay liners along each side of the tailing impoundment are proposed to further confine the seepage above the Bozeman Group. Through these features all seepage would be collected in a ditch downstream from the impoundment and diverted to a collection pond where it would be pumped back to the impoundment.

For purposes of the design analysis of the proposed drainage system the maximum amount of seepage entering the system was determined to equal the output of the tailing line during normal operating procedures (7 $ft.^3$/day per foot height of dam) plus the steady state flows from the slimes. This value is conservative, however, since no specific retention in the cycloned sands, evaporation seepage into the unsaturated alluvium behind the cutoff or other loss is considered; the total amount of water leaving the cyclones is assumed to pass directly through the cycloned sands to the drain. Total discharge to the blanket drain is estimated to be 8 to 10 $ft.^3$/day/ft. for the starter dam. The report by Sergent, Hauskins and Beckwith makes the following statement regarding the ability of the proposed drainage system to isolate the anticipated seepage:

> *The recommended preliminary design . . . results in containment of the wastes within the cutoff zones and the essentially impervious Bozeman Group and LaHood Formation. Thus, it appears that the design approach will achieve, from the practical engineering standpoint, a zero discharge facility.*

Because of the proposed use of finger drains, clay liners, and a cutoff trench, and the impervious nature of the Bozeman and LaHood formations that underlie the impoundment site, it can be concluded that the threat for seepage of contaminated waters into the area's ground water system is slight. It is possible, however, that a drainage system failure, or an irregularity in the underlying soil materials could allow seepage to the ground water system during the life of the project. This seepage would typically have a high pH, with high total suspended solids and possible high metal content. It is doubtful that the pH of the solution, however, would remain at high enough levels required to maintain the presence of cyanide during its seepage to the ground water. As discussed previously, cyanide breaks down to cyanate once the pH of the solution drops below 10. Analysis of groundwater samples taken from near the impoundment site in August indicate a receiving ground water pH of 5.8. The presence of significant amounts of heavy metal ions in the seepage would be of a potentially greater concern. Because of the seepage potential, though slight, Placer Amex Inc. has proposed the installation of monitoring wells downstream from the tailing impoundment to detect the seepage of any contaminated waters into the ground water. If seepage of contaminated waters was detected, appropriate mitigation measures would be initiated to reduce or eliminate the seepage.

(b) Impoundment Stability

Massive failure of the proposed tailing impoundment would have serious water quality impacts to the area's surface and ground water systems. The probability of such a failure in a properly designed impoundment facility, however, is very low, and the mode of failure would be important, i.e., a slow versus rapid failure. If the failure was slow, appropriate corrective or preventive measures could be initiated. In the event of a rapid massive failure, however, little could be done to prevent the failure.

The greatest potential for a rapid massive failure would occur during a seismic event (earthquake) of strong enough magnitude to liquify the tailing impoundment and initiate failure of the dam structure. If the ground motion (acceleration) were large enough or of long enough duration, the tailing would "liquify" as water trapped between the particles was freed by the shaking. If the liquefaction extended into the dam structure, stability of the dam would be severely reduced and massive failure could occur. Because of this potential threat, Placer Amex Inc. completed a comprehensive study of the seismic risk associated with the proposed tailing impoundment site. Data obtained from the study (Sergent, Hauskins and Beckwith, 1980) was then used to develop a preliminary design for the tailing dam capable of withstanding the largest magnitude earthquake anticipated as probable for the area.

As indicated in the geology section of this document two systems, the Lombard and Madison Fault Systems, were identified as possibly influencing the impoundment site. Relative to evaluation of dams and other important structures, a fault is generally classified as active in the engineering sense when it displays offsets which have occurred in the last 10,000 to 35,000 years. Based on geologic evidence, historical seismic events, and surface rupture, the Lombard and Madison Fault Systems must be considered active by this criteria.

In order to evaluate the earthquake design parameters, estimated maximum credible earthquakes for the Lombard and Madison Fault Systems were developed. Estimates were made on the basis of empirical relationships between length of surface rupture and earthquake magnitude. Effective peak horizontal ground acceleration (EPA) at the site produced by the hypothetical earthquake was also calculated from attenuation curves. Of special interest is the occurrence of the 1925 Clarkston earthquake a distance of 24 miles from the proposed impoundment site. Magnitude of the Clarkston earthquake was 7.0. A reoccurrence of such an event would produce an estimated EPA of 0.18_g at the site, sufficient to cause liquefaction of tailing materials in a saturated impoundment. For this reason, additional detailed studies including a determination of a Liquefaction Potential Index or LPI and psuedostatic stability analyses were completed for the proposed tailing impoundment design by Placer Amex Inc. Conclusions reached concerning the liquefaction hazard indicated that the inclusion of the proposed drain system in the impoundment design would result in a low phreatic surface near the crest and beneath the dam, severely limiting the potential for a liquefaction induced failure.

Additional detailed information regarding the determination of the potential reoccurrence of a major seismic event in the vicinity of the proposed tailing impoundment is presented in Appendix D.

If, as a result of massive failure, tailing materials were to reach the area's surface water resources, the most probable area to be immediately affected would be the Jefferson Slough. Since the Jefferson Slough is an important trout spawning area, the massive amounts of sediment associated with the tailings and the possible high concentrations of contaminants in the tailings could severely impact the the Slough, as well as receiving waters downstream. The threat of tailing material actually reaching the slough, however, is slight because of the distance involved, and the diversionary action that the frontage road and Interstate Highway 90 would provide. As stated previously, the type of failure and other characteristics of the situation would determine the extent of tailing movement. Of perhaps greater threat would be a partial failure of the tailing structure that would result in deposition of tailing and process waters downstream from the bentonite cutoff trench. Process waters containing contaminants would be free to seep into the alluvial fill overlying the Bozeman and LaHood formations. The seepage could then enter the ground water system of the area and potentially threaten the nearby wells and surface water systems, initiating costly monitoring programs to determine the threat to human health from consumption of the waters.

(c) Diversion System

The proposed surface drainage diversion system is designed to accomodate the maximum anticipated surface runoff event. From a 100 year, 24-hour duration storm, a maximum combined flow of approximately 1100 cfs (cubic feet per second) would exit from Diversion Channel No. 2 (Figure 7). This would cause a flow of approximately 2.5 feet deep in the natural drainage below the outlet of the channel. Water velocities in the drainage would be excessively high and would potentially cause unacceptable channel erosion. Placer Amex Inc. has proposed the installation of rock-fill check dams in the drainage to control channel velocities and recude the erosion potential. Regardless of these measures, however, during peak discharge events additional sediment would be introduced to the natural drainages receiving the diversion dam overflow. Unless the accumulation of sediment in these drainages were monitored, it is possible that the channel morphology of the drainages could be altered during the life of the project, resulting in increased erosional hazards.

Although the proposed diversion system has been designed to accomodate a 100 year 24-hour precipitation and runoff event, it is possible that these surface flow amounts could be substantially exceeded by either a single precipitation event in excess of the 100 year, 24-hour design event, a combination of precipitation events occurring in rapid succession, or a snow-melt runoff event of unusual magnitude. If this were to occur either during the life of the project or after reclamation of the tailing impoundment, over-topping, or failure of the diversion structures could occur. If structure failure were to occur during the life of the project, it is possible that the integrety of the tailing impoundment could be threatened. The likelyhood of this, however, is slight, and would be dependent upon several factors including the magnitude of the event, and the condition of the tailing impoundment (size and season of operation). In addition, a freeboard would be maintained on the tailing dam to accomodate additional storage.

In the diversion system failure were to fail following completion of the tailing impoundment reclamation, an unknown amount of water and debris would be deposited on the reclaimed surface, possibly jeopardizing the established reclamation. If the event were of large enough magnitude, and a surface flow across, or ponding and over-topping of the tailing impoundment were to occur, the erosionary action could result in a partial failure of the structure and subsequent deposition of tailing material downstream. Such tailing deposition, as discussed earlier, could result in the contamination of the area's ground water resources.

C. The Biological Environment

1. Vegetation

Vegetation communities of southwestern Montana are variable and complex, relating to differences in soils, precipitation, geology and topography. Major vegetation types observed in the proposed mining area include grassland, sagebrush, mountain shrub, conifer and meadow. Vegetative species observed in the project area include needle-and-thread grass, blue grama, bluebunch wheatgrass, Idaho fescue, sedges, rushed, bromegrass, rabbitbrush, horsebrush, rose, mountain mahogany, snowberry, creeping juniper, chokecherry, Rocky Mountain juniper, big sagebrush, mountain sage, and lodgepole pine.

The major impact to the flora, although not considered significant would be the destruction of vegetation in al disturbed areas of the proposed operation during the life of the mine, and the reestablishment of an altered vegetation community.

The proposed reseeding mixture does not contain any shrubs or forbs which presently occur over much of the proposed mine site. Reclamation of the mined area would be limited to grasses. As a result, the vegetation of the reclaimed area would not be as diverse as prior to mining

Undesirable invader species will also probably proliferate on disturbances caused by the operations and, although they will have the beneficial aspect of holding soils and building soil organic matter, they have the detrimental properties of competition with more desirable species and propagation of a seed source for further distribution.

Native vegetation and reclamation areas in the vicinity of the mining area, overburden disposal areas, soil stockpiles, facitilites and along roads will be affected by dust. Dust caused by these activities will affect vegetation to an unknown dgree. It is expected that dust from all operations will not be sufficient enough to cause damage.

Placer Amex Inc. has proposed the use of an experimental tailing disposal area for studying the reclamation success of various types of vegetation during the life of the mining operations. Through this program it is hoped that a reclamation project assured of success can be developed during the operations. The implementation of such a program is anticipated to greatly increase the likelyhood of successful reclamation of the tailing impoundment.

2. Wildlife

a. Terrestrial

The proposed mine site permit area contains habitat suitable for many types of terrestrial wildlife, including mule deer, antelope, small mammals, and many bird species, including raptors.

Perhaps the most significant impact upon these wildlife species would be the destruction, for the life of the mine, of approximately 160 acres of habitat by the development of the tailing impoundment. Antelope, in particular, which presently use the area seasonally, would be affected. The habitat areas proposed for destruction by the mining operation, however, are not considered uniquely different or limited when compared with adjacent lands. The impact of the habitat loss for the life of the operation, therefore, is not considered to be significant. Additional human activity in the vicinity of the mine site during mining operations, however, as well as increased off-site wildlife harassment by mining related employees could adversely affect the wildlife presently found in the area. No endangered or threatened wildlife species are known to exist in the proposed permit area.

b. Fisheries

The proposed minesite does not contain habitat suitable for the existance of a fishery, however, the two major rivers in the adjacent area, the Boulder River and the Jefferson River both sustain sizeable fisheries.

The Boulder River supports populations of Brown trout, Rainbow trout, yellow perch, white suckers, longnose suckers, and golden shiners. In the fall, Brown trout use the lower end of the Boulder to spawn. Tagging information indicates fish return from the lower Jefferson, Willow Creek (upstream from the Missouri), the Missouri, and the Jefferson Rivers. A number of diversions have been built along the Boulder River and seriously dewater the lower portions during low flow periods. This acts to reduce Brown trout migration into the tributaries and headwaters as occurred historically.

Studies by Nelson (1977) and Gardner (1976) indicate leaching of old mine dumps in the upper Boulder tributaries has distributed heavy metals, particularly zinc and mercury throughout the drainage and into the Jefferson River. However, research to date concerning the effects of heavy metals on aquatic organisms and the aquatic food chain is uncertain. Evidence indicates that a chronic problem probably exists but to date precise definition has eluded researchers. A great deal of sediment is contributed by waters flowing through the abandoned mine areas and is thought to be a chronic source of stress to the fisheries river system.

The Jefferson River supports populations of Brown trout, Rainbow trout, mountain whitefish, white suckers, longnose suckers, carp, burbot, and in the lower river, large mouth bass and yellow perch (Rehwinkel, 1981). Data gathered by the Department of Fish, Wildlife and Parks indicate spring population levels of up to 700 catchable size (7" or greater) fish per mile of stream. The Jefferson also suffers from dewatering and sedimentation as described in the previous section. A study of aquatic insects related to instream flows (Oswald 1979) indicates good aquatic insect variety, despite periodic dewatering and, comparatively lower numbers than other Missouri River tributaries.

The Jefferson slough is a gathering site for trout during the autumn migration. Diversions along the upper Boulder and lower Jefferson result in serious dewatering during low flow times of the year as discussed in Section A.7. Low water depths drive migrating fish to deeper waters, particularly areas of Jefferson slough. The remainder of the year, fish populations in the slough are comprised mainly of non-game fish such as carp and golden shiners.

Impact to the area's sport fishery as a result of the proposed mining development could occur in the following manner:

1) Construction of the proposed mining development could result in an increase in the amount of sediment present in the ephemeral drainages adjacent to the mining operation. A peak precipitation or runoff event could result in the discharge of the increased sediment load into surface water systems, where it would eventually find its way to waters containing a sport fishery. Increased sedimentation can adversly affect fish by 1) altering the habitat of aquatic insects, a major food source for salmonid (trout) species, 2) increasing water temperatures if it is suspended in sufficient amounts, and 3) damaging, through abrasion, of the fish's gills with a resultant increase of the threat for infection and death.

2) Salmonid fish species are very sensitive to cyanide and metal-complex concentrations in water. Seepage of these materials into the area's ground water resources from the tailing impoundment, or their entry into the surface water system through a catastrophic failure of the tailing impoundment would seriously impact the sport fishery at the point of entry and an unknown distance downstream.

3) In addition to the direct impact potentials identified above, the sport fishery of the general area may also experience indirect adverse impacts related to increased fishing pressure. Secondary development of the area would have the potential to increase the numbers of fishermen using the area, often causing additional disturbance through careless activities. The potential for direct impact to the area's sport fishery through the development of housing or other development related construction immediately adjacent streams or other surface water is also present.

C. The Social and Economic Environment

1. Land Use

Land use in the proposed permit area presently includes seasonal grazing by livestock, wildlife habitat, and continuing exploration for minerals suitable for development. Although areas presently used for grazing by livestock and as wildlife habitat would be committed to use as mining related facilities during the life of the operation, successful reclamation would reestablish these prior use possibilities.

2. Income, Employment and Taxes

A significant increase in employment, up to a total of 200 employees during the construction phase, would be required for the proposed new mining operation. Federal and state income taxes are paid on the wages earned by Placer Amex employees. There are five separate taxes in Montana which apply directly to the proposed Placer Amex mining operations. These taxes and the amount of revenue which would be generated by the proposed mine is summarized in the following table:

TAX	$/ YEAR
Gross Proceeds Tax 1/	200,000
Resource Indemnity Trust Tax 2/	175,000
Metalliferous Mines License Tax 3/	500,000
Corporation License Tax 4/	830,000
Property Tax	540,000
TOTAL	$2,245,000

1/ Gross Proceeds Tax - The Gross Proceeds Tax functions as a property tax on minerals extracted from a county. A county-wide mill levy is applied against the taxable value of mine production. This taxable value represents 3 percent of the merchantable (market) value of the ore.

2/ Resource Indemnity Trust Tax - The purpose of the Resource Indemnity Trust Tax is to make money available to improve the total environment and rectify damage caused by past mining operations. The tax is applied to all mining activity in the state. Its rate is one-half of one percent of the gross value of a mine's production.

3/ Metalliferous Mines License Tax - The Metalliferous Mines License Tax is collected by the Department of Revenue for the State of Montana. This tax also is based upon the gross value of annual production and is levied on a graduated basis, increasing as the gross value of production increases. Assumptions of constant mineral price and rate of production used for other tax projections apply to these estimates as well.

4/ Corporation License Tax - The Corporation License Tax is in reality a corporate income tax levied by the state, The license fee is derived as a percentage (6.75%) of a corporation's annual net income. Revenue generated by the tax is allocated to the state's general fund.

3. Human Health and Safety

The proposed mine, waste dump, roads, and tailing impoundment may produce additional dust particulate, the influence of which as a contribution to respitatory diseases and ailments of the human population in the immediate vicinity of the proposed operation is unknown. Dust abatement and proper mamagement of the exposed waste materials in the dump and tailing impoundment should mitigate this concern.

The proposed mine, dump, and tailing impoundment area may also contribute an "attractive nuisance" in the area and could cause injury or loss of life to individuals who trespass into the mine area during the life of the proposed operations. To assist in revegetation efforts and to aid in safety promotion, the tailing impoundment would be fenced to further restrict access to the area by both livestock and people.

4. Archeological and Historical Sites

A cultural resource inventory and evaluation of the proposed permit area was conducted by the Cultural Resources Division of the Mineral Research Center, Butte, Montana; in October 1980. According to the results of the study, the proposed permit area appears more limited in number of archeologic sites than several adjacent areas to the east. In total, two prehistoric sites, one historic site, and nine minimal activity areas (MALS) were located.

The Mountjoy-Wegener Homestead site consists of a concrete foundation and basement, a stone slab foundation, a wooden platform, some concrete blocks, the remains of a stock pond, wooden and sheet metal water flume, and an apple orchard. The Hoestead Entry Patent date for the site is 1915.

Ralph's Place site is an archaeological site of unknown time period, consisting of two possible hearths and lithic scatter. This site may have functioned as a small seasonal campsite. Some bificial reduction took place here as indicated by the presence of hinged platform flakes. Two incomplete points were also located at the site.

The Lee Ring Site is a prehistoric site consisting of three stone circles. A quartzite grinding stone was found east of one of the stone circles. This was the only cultural artifact observed at this site.

The nine minimal activity locations (MALS) are all historic in nature and consist of a trash scatter. two trash dumps, scatter of wooden board, rock cairn, two mining prospect holes, a wooden frame, and a wooden water flume.

Impacts of the proposed mine would include destruction of three MALS which lie within the area proposed for the tailing impoundment. The other seven MALS and two recorded sites will not be affected by the proposed development. All sites have been examined, evaluated, mapped, and photographed. Little enough material remained so that the information is archival rather than physical. The recording of the features effectively mitigated the sites.

None of the three sites, or the nine MALS are considered eligible for nomination to the National Register of Historic Places, and the study recommended no further work for any of the sites or MALS.

5. Visual Resources

The area of Sunlight Gulch, because of its past history of mining, has undergone periodic extensive disturbance. Roads and old exploration sites are visible from both State Highway 281, and Interstate Highway 90. The present disturbance, plus the proposed mine site, mine waste dumps, mill site, and tailing impoundment would further reduce the aesthetic value of the area.

The proposed tailing dam and impoundment would be highly visible for a short distance along State Highway 281, and Interstate Highway 90. Dust from the mining operation may contribute to a reduced visual resource in the area. Successful reclamation of the roads, millsite, tailing dam, and impoundment would mitigate these impacts.

6. Recreation

The proposed permit area is privately owned, and is not presently used for recreational purposes. The operation of the proposed facilities would not significantly affect the recreational resource of the area, although increased noise caused by blasting and heavy truck traffic could reduce the recreational experience in areas immediately adjacent the operations.

7. Community Services

a. Schools

The number of students enrolled in the Whitehall school system has declined in recent years. The present capacity of the system from kindergarden through grade twelve is 850 students. The September 1980 enrollment in the system was 711 students. The District Superintendent of Schools has indicated that the system could accomodate up to 140 additional students without stress (Appendix E). The proposed mining project would undoubtedly contribute some new students to the system, but it is considered unlikely that enrollment would rise to a point exceeding capacity. Additional students would result in a slightly greater tax base and would provide a stabilizing factor for the presently declining enrollment.

b. Housing

Available housing in the adjacent community of Whitehall, Montana is very limited at the present time. If the majority of the work force of 120 operational employees were to chose to reside in Whitehall, additional housing would have to be provided. Initially, the lack of available housing units could trigger increased mobil home settlement in the area. If demand for housing were strong enough, however, additional home construction in the area could result. Additional housing unit needs, regardless of the kind, would be expected to put increased importance on the planning needs of the community, and increase the potential for adverse development related impacts. Potential housing related impacts to the community could be effectively mitigated by Placer Amex Inc. by hiring locally-based employees if possible.

D. Significant Adverse Impacts that Cannot be Avoided if the Proposals are Implemented

Perhaps the major adverse impact that cannot be avoided is the potential threat of the introduction to the area's surface and ground water system of potentially hazardous substances through unplanned circumstances such as employee error, facility malfunction, or act of nature.

E. Relationship Between Short-Term Uses of Man's Environmental and the Maintenance and Enhancement of Long-Term Productivity

The proposed activities would result in a permanent change in topography at the mine site including the open-pit area, and associated waste dumps. Permanent change in topography would occur within the proposed permit area by construction of the the tailing dam and impoundment. The activities would intruduce long-term changes in related environmental factors affecting long-term productivity of the area. Changes in slope magnitude and slope aspect or direction would alter the local microclimate, producing corresponding changes of type, density, and vigor of the plant cover. This in turn would affect infiltration, runoff, erosion and sedimentation, and productivity or carrying capacity for wildlife.

The proposed mining activities would increase the total suspended particulate levels in the air during the development and operation of the project. The cessation of this activity and successful reclamation would end the impact on air quality directly related to the project.

The proposed mining activity represents a short-term productive use of the mineral reserves. The long-term effect on the productivity of the locatable mineral resource present would be a decrease in productivity until the mineral resource of the mine is totally depleted.

Soil disturbances as a result of the proposed action would alter soil characteristics and probably casue some lone-term decline in soil productivity. Soil losses would occur from accelerated erosion on denuded and disturbed areas during operation and reclamation. Also, organic content and biological activity in the replaced surface layer would be temporarily decreased by soil removal and stockpiling.

The short-term use of the land for mining could result in a long-term reduction of biological productivity depending on the success of reclamation. Care must be taken that the tailing dam and tailing impoundment operate correctly to insure that contaminating substances do not escape into the environment.

If care is taken to salvage and replace all available topsoil, prevent, erosion, and establish grasses, forbs, and shrubs adopted to the sites, post-mining biological productivity should eventually approximate existing productivity. Sepcies diversity will remain low after reclamation until natural reinvasion can increase the number of species occurring of the revegetated areas.

On a site-specific basis, the short-term use of the land to mine minerals is a disturbance that will result in the long-term alteration of wildlife habitat on areas to be disturbed. The alteration, however, is not anticipated to significantly affecting existing wildlife use of the area.

Jefferson County's economic environment would undoubtedly receive direct stimulation through additional employment and mining production as a result of the proposed operation.

The archeologic and historic survey of the proposed permit area offered a short-term use of these resources. Long-term use of these resources is the record of this statement, and the report by the Mineral Research Center which contains maps of the survey area and sites and historic finds.

F. Irreversible and Irretrievable Commitment of Resources

The proposed mining activity could irreversibly commit the entire gold deposit within the permit area to depletion. Mineral deposits are unique, highly finite and valuable features of the earth's crust, formed by slow processes still active today. Mining of the mineral resources is a depletion of a resource that will require millions of years to be replenished, possibly never (localized) in the same area.

The land itself may be committed to other uses as a result of its initial commitment to the proposed action. Other uses for the mine may be identified and this could delay or halt full restoration of the mined area.

The proposed mining of gold and the reclamation of disturbed areas at the proposed mine site would require the use of liquid fuels in the form of diesel fuel and gasoline, electrical power, and structural and repair materials. In addition to fuel and explosives, an unquantifiable amount of materials used in the mining and subsequent reclamation processes would also be irretrievably lost for other uses.

Unless the mine area and all associated facility sites are reclaimed to their condition prior to disturbances, the potential for reduced carrying capacity must be considered a partial irretrievable commitment of the wildlife resource.

The capital investment in plant and productive equipment at the mining termination is irretrievable and irreversible once committed, if not alternate usage can be found. Labor invested in mining is irretrievable once expended, but the labor commitment is reversible should a premature termination occur. Similar commitments and investments on a smaller scale may develope in the government, trade and service sectors of the local economy with congruent irreversible and irretrievable outcomes.

Such an investment and commitment of human and economic resources is required for any economic activity. But unless the venture fails, this is a beneficial and necessary application of resources to continue employment and expand sources of personal income.

Archeological and historical sites or artifacts are nonrenewable and hence long-term resources. In the event that significant sites are not discovered and are destroyed during the mining process, the physical resource loss would be irretrievable. In addition to such a possible loss of physical resources, educational and scientific information regarding prehistoric environments and our cultural heritage would also be lost to both present and future generations.

III. MITIGATING OR COMPENSATING MEASURES

Three basic types of mitigating measures have been recognized as relative to the Placer Amex proposal. They are: (1) measures required by Local, State, or Federal laws, regulations, or executive; (2) measures proposed by Placer Amex as part of their mining and reclamation plan; and (3) other measures generally thought to have merit. The first two categories include those measures that are binding and must be implemented upon approval of the proposal and issuance of the various agency permits associated with the mining proposals. By attachment of stipulations, other measures comprising the third category may be required as part of the companies' reclamation plans in those instances where the permitting State or Federal agencies have the authority to do so. Inclusion of these other possible measures in the environmental impact statement affords a practical means of utilizing the expertise of agency members to identify additional measures that, if implemented, would further reduce adverse impacts of the proposal. Inclusion of these other mitigating measures in this statement in no way obligates Placer Amex or restricts the decision-making prerogatives of the State regulatory agencies.

A. Laws and Regulations

1. General Statement

The proposed mining operation must comply with all applicable regulations of Federal, State, and County agencies including:

Mine Safety and Health Administration (Federal)
Montana Department of State Lands
Mongana Department of Health and Environmental Sciences
Jefferson County, Montana

Regulations enforced by the above agencies are variously designed to assure realization of the full and best interests of the public, to adequately protect the environment, and to achieve continuing highest productive use of the land consistent with surrounding land uses and management objectives.

2. State Laws

Significant State Laws for mitigating impacts include:

(a) Montana's Metal Mine Reclamation Act defines reclamation requirements necessary for Departmental acceptance of the applicants reclamation plan, as well as other mitigating measures including accomplishment of specific activities, inspections of mining sites to determine compliance with the reclamation plan, performance bonds, and an annual report of activities by the permittee. In addition, all fees, fines, penalties, and other uncleared moneys which have been or will be paid to the Department of State Lands under the provisions of this part shall be placed in the earmarked revenue fund in the state treasury and credited to a special account to be designated as the hardrock mining and reclamation account. This account shall be available to the Department by appropriation and shall be expended for the research, reclamation, and revegetation of land and the rehabilitation of water affected by any mining operations.

(b) Montana's Clean Air Act (Title 75, Chapter 2 MCA) and administrative rules adopted thereunder defines air pollution and provides for enforcement and control of those activities exceeding appropriate air quality standards.

(c) The State Antiquities Act, (Title 22, Chapter 3 MCA) which is administered by the Board of Land Commissioners and the Montana Historical Society, provides for the registration and protection of historic, prehistoric, archeologic, paleontologic, scientific, or cultural sites and objects on state lands. It also provides that the Department is authorized to enter into cooperative agreements with private landownersto preserve, mark, maintain, excavate, or otherwise deal with such sites and objects upon such terms as may be agreed upon.

3. Federal Laws

The mining companies must comply with standards and guidelines established by the Mine Safety and Health Administration to protect the health of employees involved in the mining process.

4. Jefferson County Laws

The facilities, including equipment and land of the proposed mining project would be subject to a property and gross proceeds tax levied by Jefferson County. The proceeds primarily would help fund consolidated school districts 4,47,2 in Madison and Jefferson County. The gross proceeds tax is in effect a property tax on a mineral resource. It would be based on the dollar value of the mineral extracted from the mine in any given year.

5. Local Ordinances

There are no known significant local ordinances that would function to mitigate impacts from the proposed mining projects.

B. Reclamation Plans and Additional Mitigating Measures

The reclamation plans proposed by Placer Amex are presented in Chapter One. In addition, the following section contains those mitigating, compensating, or monitoring measures generally thought to have merit by the Department.

Among those measures considered as mitigation are those that involve the implementation of a different or varient plan of operations. Technologic alternatives and their possible application to the proposed mining project are contained in Chapter Four.

1. Topography

General mitigation of impacts to existing topography would include;

(a) minimization of all cut and fill slopes through proper siting of all facilities to take advantage of existing topography,
(b) hydroseeding all cut and fill slopes in excess of 10 feet with seed mixture containing at least two legume species in the first appropriate season following completion of the cutting and filling,
(c) terracing of all mine waste dumps to enhance future reclamation efforts, and,
(d) replacement of a portion of the mine waste dump material within the mined-out portion of the mine.

2. Air Quality

The operator should utilize, at a minimum, the methods to control particulates as outlined in the conditions attached to the Air Quality Permit by the Montana Department of Health and Environmental Sciences (Appendix A).

3. Employee Health and Safety

Under provisions of the Federal Metal and Nonmetallic Mine Safety Act of 1966 (Public Law 89-577), MESA is responsible for the enforcement of the health and safety standards prescribed to protect the workers at all mine sites, which includes the proposed mining operations. With the signing of the Federal Mine Safety and Health Act of 1977 (Public Law 91-173), it became the responsibility of the Secretary of Health, Education, and Welfare and the Secretary of Labor to develop and promulgate improved health and safety standards for persons working at mining properties. New and/or revised regulations will be implemented by the Mining Safety and Health Administration (MSHA) under the Department of Labor.

4. Disposal of Hazardous Wastes

Under the provisions of the Resource Conservation and Recovery Act of 1976 (Public Law 94-580), EPA is responsible for the development of regulations and guidelines for disposal and management of all solid wastes, including mining wastes. EPA currently is conducting a detailed study on the adverse effects on the environment of solid wastes from active and abandoned surface and underground mines. Meanwhile, State and/or county governments where cyanidation operations exist regulate the disposal or abandonment of cyanided waste materials.

Montana adopted rules and regulations regarding the disposal of hazardous wastes in November, 1980. These rules, however, exempt mining related wastes from regulation pending the conclusions of the Federal EPA study mentioned above. Therefore, at the present time the disposal of hazardous wastes from the proposed mining operations, such as used cyanide canisters, and reagent residues does not require a permit if it occurs on private property. As a mitigating and protective measure, it is suggested that the disposal of all hazardous wastes associated with the Placer Amex Inc. operation be done by a method and in a location fully approved by the Montana Department of Health and Environmental Sciences.

5. Soils

a. Mine and Facility Sites

In all areas to be disturbed as a result of the proposed facilities, all suitable topsoiling materials should be salvaged and stockpiled.

Stripping of topsoil for stockpiling will require equipment operators to use caution and personal judgement to avoid salvage of undesirable materials. All of the soils have variable amounts of coarse fragements occurring within short distances. Equipment operators should be made aware of this.

b. Roads

All roads should be constructed according to county standards with regard to side and back slopes which include sloping, grading, and seeding. The potential for erosion and sedimentation can be further reduced by:

* using existing access roads where possible,
* designing new roads and upgrading existing roads to adequately accomodate the largest and heaviest piece of machinery involved in construction.
* reducing road grades wherever possible,
* installing cross-drainages in roads with erodible soils and steep grades,
* providing a natural vegetation buffer between roads and drainages,
* restricting wet-weather road construction, particularly on poorly-drained erodible soils,
* prohibiting disposal of excess fill material within the high-water zone of adjacent drainages,
* minimizing the number of drainage crossings, and
* avoiding roads in marshes, bogs, and other areas of extreme wetness.

6. Water Resources

Those mitigating measures identified previously in the Soils sections for reducing the potential of erosion and sedimentation apply to the mitigation of surface water impacts.

Conscientious management of the mine and milling facilities, to reduce the potential for spills of toxic materials would be necessary to insure the continued existing water quality in the area. The following measures would reduce the threat for a spill of hazardous materials in transport or at the milling location:

* the reagent should be containerized in spill-proof containers, and transported in enclosed trucks,
* reagent transport should not be attempted if adverse road conditions are present,
* employees should have knowledge of contingency plans for spills in transport,
* equipment and reagents to neutralize spills should be conveniently located and their location well known,
* there should be a timely cleanup of any spill,
* roads in steep or dangerous areas should be banked on the outslope to prevent vehicular accidents,

- a periodic safety training or refresher course for personnel in handling, operations, or transportation,

- construction of protective measures against vandalism; being alert for its occurrence,

- implementation of a surface and ground water monitoring program should occur before, during, and after completion of the project,

- development and dissemination of contingency plans by management to operators in the event spills should occur

Although Placer Amex Inc. has proposed the initiation of a ground water monitoring program in the vicinity of the tailing impoundment, an expanded program would greatly aid in the detection and prevention of possible contamination of the area's ground water resources by seepage from the impoundment. It is recommended that Placer Amex Inc. seek the advise of the Montana Department of Health and Environmental Sciences for the development of a complete monitoring program and contingency program (should seepage be detected in the monitoring program).

Because of the uncertainty regarding the potential for adverse impacts to the area's water systems, and the implementation of regulations that may be in effect during or after completion of the proposed project, a major form of mitigation to prevent the entrance of hazardous materials into the area's water resources would be for the mining companies to seek approval from the Montana Department of Health and Environmental Sciences for all activities involving the handling or disposal of toxic substances.

7. Vegetation

The following measures should be considered in addition to the reclamation requirements of the Metal Mine Reclamation Act, and should provide mitigating measures enhancing revegetation success:

- species present in the proposed disturbed areas should be selected, when available, for use in reclamation. These species have demonstrated the capability to survive the climatic vicissitutes and site characteristics of the area.
- where feasible, commercial timber of proposed disturbed areas should be harvested. Slash should be properly disposed of to reduce fire hazard.
- graded slopes should be kept as gentle as possible to enhance reclamation.

Mitigation of potential impacts to vegetation is linked closely with the successful mitigation of the impacts to the soils resource identified previously.

8. Wildlife

A direct relationship exists between the amount of land disturbed as a result of development and the impacts of such disturbance upon wildife. A conscientious effort to disturb as little land as possible would have the most immediate and long-lasting mitigating effects.

Additional stresses on the wildlife resource will occur from an increasing human population. These additional impacts can be significant if not countered with sufficient planning. Increased law enforcement may be necessary to regulate illegal killing of wildlife, and off-road vehicle restrictions and road closures may be necessary to reduce accessibility to wildlife.

Additional mitigation measures include:

- when possible, arrange work schedules so that shift changes do not occur at dusk and dawn,
- request personnel not to chase, handle, or take home any wildlife, particularly young animals,
- if possible, hunting within or around the permit boundary should be prevented, and access during hunting season should be restricted.

In addition, to reduce employee-wildlife encounters it is recommended that the mining company consider providing a bussing service to transport employees to the facility and mining sites. This would reduce collisions with wildlife and the potential for wildlife harassment.

The mitigating measures discussed in the water resources section apply equally to prevention of impacts to the area's sport fishery

9. Social and Economic

The influx of population generated by the proposed mining employment (however small) naturally implies a series of interdependent impacts on service delivery, employment, social attitudes and characteristics, and land use. The responsibility for ascertaining the needed and desirable growth patterns in the local community lies with the county government and local citizens. The adjacent communities are small enough that a town meeting approach to needs, desires, and anticipated problems cause by the proposed mining development is still a viable approach. Leadership for continuing this process could be assured by either the Jefferson County Planning Board and Commissioners, or by residents of the area.

IV. ALTERNATIVES TO THE PROPOSED ACTION

A. Introduction

Alternatives that apply generally to the development of the mineral resources in Montana include those of an administrative nature as well as those involving alternate mining and reclamation plans, technological alternatives, and reduced consumption of energy.

B. Administrative Alternatives Available to State Agencies

1. Department of State Lands

a. Approval of the Operating Permit for the Life of the Operations

Section 82-4-337 (2) and (3) of the Metal Mine Reclamation Act provide that:

The operating permit shall be granted for the period required to mine the land covered by the plan and shall be valid until the surface or underground mining authorized by the permit is completed or abandoned unless the permit is suspended or revoked by the board as provided in this part.

The operating permit shall provide that the reclamation plan may be modified by the board, upon proper application of the permittee or department, after timely notice and opportunity for hearing, at any time during the term of the permit and for any of the following reasons:

(a) to modify the requirements so they will not conflict with existing laws;
(b) when the previously adopted reclamation plan is impossible or impracticable to implement and maintain;
(c) when significant environmental problem situations are revealed by field inspection.

Section 82-4-338 of the Metal Mine Reclamation Act provides that:

The applicant shall file with the department a bond payable to the state of Montana with surety satisfactory to the department in the penal sum to be deternubed by the department of not less than $200 or more than $2500 for each acre or fraction therof of the disturbed area, conditioned upon the faithful performance of the requirments of this part and the rules of the board. In lieu of such bond, the applicant may file with the board a cash deposit, an assignment of a certificate of deposit, or other surety acceptable to the board. Regardless of the above limits, the bond shall not be less than the estimated cost to the state to complete the reclamation of the disturbed land. A public or governmental agency shall not be required to post a bond under the provisions of this part. A blanket performance bond covering two or more operations may be accepted by the board. Such blanket bond shall adequately secure the estimated total number or acres of disturbed land. When determined by the department that the set bonding level of a permit or license does not represent the present costs of reclamation, the department may modify the bonding requirements of that permit or license.

No bond filed in accordance with the provisions of this act shall be released by the department until the provisions of this act, the rules adopted pursuant thereto and this reclamation plan have been fulfilled.

b. Suspension of Permit

Section 82-4-362 of the Metal Mine Reclamation Act provides that:

If any of the requirements of this act or the rules or the reclamation plan have not been complied with within the time limits set by the department or board or by this act, the department shall serve a notice of noncompliance on the licensee or permittee, or where found necessary, the commissioner shall order the suspension of the permit.

c. Denial of the Operating Permit

Section 82-4-351 of the Metal Mine Reclamation Act provides that:

A permit may be denied for any of the following reasons:

(a) The plan of development, mining, or reclamation conflicts with the state water and air purification standards;
(b) The reclamation plan does not provide and an acceptable method for accomplishment of reclamation as required by this act.

In addition, section 82-4-352 provides that:

A permit may be denied and returned to the applicant with a request that the application be resubmitted with a different plan for reclamation. The person making application for a permit may then resubmit to the board a new plan for reclamation.

2. Department of Health and Environmental Sciences

The Department of Health and Environmental Sciences approved the Air Quality Permit for the proposed Placer Amex Inc. development prior to the preparation of this document.

C. Alternative Technology

1. Underground Mining

The existing ore body is of low quality and requires a high volume removal and processing rate. Because of this, underground mining cannot be economically used to remove the ore for processing. As further exploration is completed at the site, and the open-pit mining has progressed substancially, it may be possible that areas of ore may be identified that can be mined using an underground mining technique in the future.

2. Alternative Processing

In the past, a cycanide heap leaching process was tested on the ores of the proposed mining area on a limited scale. The results of the heap leaching tests indicated that the ores could not be economically processed using the heap leaching methods. A milling process is required to free the mineral values present in the ore.

3. Surface Drainage Control

As an alternative to the proposed system of diversion dams and ditches for the control of surface drainage upstream of the tailing impoundment, additional storage capacity could be provided by the tailing dam. While this could be accomplished relatively simply by adding more freeboard to the structure, the proposed diversion system is considered to have several advantages, including 1) diversion of peak precipitation events from the tailing dam structure that could encourage erosion of the structure, and 2) diversion of surface flow from the surface of the tailing impoundment upon completion of the mining operation, thereby aiding in the drying of the impoundment surface and encouragement of the reestablishment of vegetation on the structure.

4. Tailing Disposal

The reintroduction of tailing material into the open-pit mine, rather than its storage in a tailing impoundment is not considered possible because of the nature of open-pit mining. In an expanding open-pit mine areas previously mined are continually being redisturbed, preventing the use of these areas for the storage of tailing. Tailing storage is possible in some types of underground mines, and if the mining where to ever use underground mining methods in the future, it is possible that a portion of the tailing could be disposed of in this manner.

5. Ore Processing at Existing Facilities Elsewhere

The low grade of the ore involved, and the large volume of processing required prohibit transport of the ore to other existing facilities elsewhere in the state.

6. Neutralization of the Cyanide in the Tailing Impoundment

As an alternative to the proposed plan of recycling the tailing waters for use in the milling process, Placer Amex Inc. could neutralize the cycanide containing waters as they left the processing facilities, and use entirely new cycanide and new process waters in the milling facilities. Numerous methods of affective cycanide neutralization are available for use on the process waters. This procedure is not considered to be economically, or engineeringly sound for this project, however. Cyanide is expensive, and because of the low grade of ore involved, every effort must be made to recycle it for use in further processing. In addition, the use of the tailing impoundment for storage of a greater amount of water, as would be required if the milling process did not recycle the previous process water, would present additional engineering concerns regarding stability and saturation of the dam structure and finger drains.

V. CONSULTATION AND COORDINATION WITH OTHERS

A. Development of Statement

This environmental statement was prepared by the Montana Department of State Lands. Contributions were provided by the following:

State Agencies

Montana Department of State Lands
    Ralph Driear, Environmental Administrator
    Patricia Howe, Asst. Environmental Coordinator
    Steve Anderson, Chief, Hard Rock Bureau

Montana Department of Health and Environmental Sciences
    Harry Keltz, Air Qualtiy Bureau

Montana Department of Fish, Wildlife, and Parks
    Bruce Rehwinkel

Private Organizations

Mineral Research Center, Butte, Montana

Additional participation and assistance were obtained from many sources. Placer Amex Inc. provided data and information on their proposed activities, as well as numerous visual aids. Comments of residents of the area and others were especially helpful in the preparation of this document.

B. Review of Statement

In accordance with the Montana Department of State Lands rules and quidelines, copies of the draft statement are being made available to the public for their comments and suggestions.

References

Alexander, R.G., 1955, Geology of the Whitehall Area, Montana, The Yellowstone-Bighon Research Association Contribution No. 195.

Bahls, Loren L., Gary Ingman, and Abe Horpstad, 1979, Biological Water Quality Monitoring, Southwest Montana, State of Montana Water Quality Bureau, Department of Health and Environmental Sciences.

Doudoroff, Peter, 1956, Some Experiements on the Toxicity of Complex Cycanides to Fish, Sewage Ind., Wastes 28:1020-1040

_______________, 1976, Toxicity to Fish of Cyanides and Related Compounds, a Review, EPA-600/3-76-038. 154pp.

Doudoroff, P., G. Leduc, and C.R. Schneider, 1966, Acute Toxicity to Fish of Solutions Containing Complex Metal Cyanides, in Relation to Concentrations of Molecular Hydrocyanic Acid, Trans. Am. Fish. Soc. 95:6-22

Gardner, William, Effects of Heavy Metals on the Distribution and Abundance of Aquatic Insects in the Boulder River, 1977, unpublished Master's Thesis, Montana State University, Bozeman, Montana.

Nelson, Fred, 1976, The Effects of Metals on Trout in the Upper Boulder River, unpublished Master's Thesis, Montana State University, Bozeman, Montana.

Oswald, Richard A., 1979, The Distrubution and Abundance of Aquatic Macroinvertebrates as Related to Instream Flows in the Jefferson River, Montana, U.S. Fish and Wildlife Report.

Rehwinkel, Bruce, Personal Communication, January 1981, Fisheries Biologist, Montana Department of Fish, Wildlife, and Parks.

Robinson, G.D., 1963, Geology of the Three Forks Quadrangle, U.S. Geological Survey Professional Paper No. 370.

Sargent, Hauskens and Beckwith, 1980, Interim Geotechnical Report, Preliminary Site Evaluation, Golden Sunlight Project, Placer Amex Inc., Jefferson County, Montana, SHBJOB No. E80-89, Interim Report No.2.

APPENDIX A

AIR QUALITY PERMIT AND ANALYSIS

AIR QUALITY PERMIT

Issued to:	Placer Amex Inc. One California Building Suite 2500 San Francisco, CA 94111 and/or Placer Amex 200 N. Brooks Whitehall, MT		Permit # 1499 Date Recd: May 9, 1980 Date Filed: August 9, 1980 Date Issued:

SECTION I: Permitted Facilities

An air quality permit is hereby granted to the above named permittee, hereinafter referred to as recipient, pursuant to Section 72-2-204 and 211, MCA, as amended, and Sub-Chapter 11, Permit, Construction and Operation of Air Contaminant Sources, ARM rules Sec. 16.8.1101 through Sec. 16.8.1118.

A. One surface gold mine with the necessary extraction facilities to produce 1,750,000 tons of gold ore and 2,275,000 tons of waste annually. Total life of the mine is estimated to be 30 years.

B. Areas of disturance, ore handling facilities and associated equipment:

1. Open pit - 63 acres
2. Tailings Pond - 210 acres
3. Millsite - 24 acres
4. Dumps - 30 acres
5. Haul Roads
6. Primary Crusher
7. Fine Crushing Area
8. Transfer Tower
9. Fine Ore Reclaim
10. Coarse Ore Bin Dumping
11. Fine Ore Stock Transfer
12. Fine Ore Stockpile
13. Primary Coarse Ore Feeder
14. Tailings Pond

C. Necessary Auxiliaries

Blasthole rigs, front-end loaders, shovels, dozers, scrapers, graders, trucks, cranes, power facilities, storage and equipment housing, etc.

Section II: Limitations and Conditions

A. The recipient shall notify the Air Quality Bureau in writing when construction of the Golden Sunlight mine commences operation. Said notification shall be given within ten days of commencement of operation.

B. Recipient shall enclose all crushing, handling, conveying and storage areas except as otherwise noted. The coarse ore stockpile need not be enclosed unless investigations by the Bureau determine otherwise.

C. A contingency plan for enclosing the 25,000 ton fine ore stockpile shall be submitted by March 1, 1981. Investigation after operations commence shall determine whether construction of permanent enclosure is necessary. The contingency plan shall be due in our office by March 1, 1981, and implementation of said plan and construction of necessary facilities shall be completed at a time to be determined by the Bureau.

D. Recipient shall apply chemical dust stabilizer to all permanent haul roads when necessary. The type of permanent dust control utilized shall be worked out with the Air Quality Bureau by March 1, 1981. A report on the successof the stabilizer chosen shall be made to the Bureau by July 1, 1982.

E. All pick up and conveyor points in the fine crushing building shall be vented to a 42,000 CFM wet spray scrubber or equivalent.

F. The fine ore reclaim and conveyor area in addition to being enclosed shall install a 6500 CFM wet scrubber or equivalent to control dust emissions.

G. The carbon regneration operation shall be enclosed and any fines produced shall be scrubbed by a 2500 CFM wet scrubber or equivalent.

H. Refinery operations shall be enclosed and any emissions generated shall be scrubbed.

I. Recipient shall provide the Department (Bureau) with all necessary plans and details on the wet scrubbing systems so chosen once a final engineering plan has been accepted.

J. The recipient shall not cause visible emissions of greater than twenty (20) percent to be discharged into the atmosphere from any ore, product handling, crushing, conveying or storage system or area of disturbance.

K. Source tests on all source discharge points shall be necessary to determine whether Best Available Control Technology has been applied. These tests shall take place 120 days after the mill is operating at its rated capacity or as may be determined necessary by the Department. Test methods shall be specified by the Department.

Department and Bureau are used interchangeably throughout this discussion.

L. Recipient shall take whatever measures are necessary to control visible emissions from the tailings pond including revegetation, mulching or other means. A plan for controlling these emissions should they materialize, shall be submitted to the Department by March 1, 1981.

M. Recipient shall maintain and operate its mine with the technologies and techniques as specified under EPA's "best management practices" for coal mines when applicable. Document available upon request from the Department.

N. Two dust fall and TSP monitoring sites shall be chosen upon consultation with the Department. The Total Suspended Particulate (TSP) monitors shall include as a minimum one upwind TSP monitor and two monitors downwind (co-located).

SECTION III: Monitoring and Reporting'

A. Recipient shall provide an annual report to the Department within sixty (60) days of the end of each calendar year. The report shall include all necessary information to determine compliance with the conditions of Section II; including but not limited to, amount of ore and waste produced, maximum amount of disturbed area, and such other information that may be necessary to determine mine and mill impacts on the ambient air.

B. TSP sampling shall be conducted once every sixth day or approximately five times per month.

1. At least one meteorological and climate station shall be installed after consultation with the Department.

2. Recipient shall follow EPA quality assurance practices A. B. and E (44FR-27588-604).

3. Reporting - Recipient shall submit all required data to the Department (AQB) quarterly. Said data shall also be submitted to the Department of State Lands on the some frequency.

4. An annual report should ideally summarize the data, develop meteorological correlations, show trends, list violations (if any), discuss control measures for meeting all ambient standards (if necessary). This report shall be submitted to the Air Quality Bureau within 60 days following a year of air monitoring.

C. In light of the new enforceable Montana ambient air standards, Placer Amex shall submit their data reflecting both the annual arithmetic and geometric mean values.

D. The Air Quality Bureau or its consultant may audit the particulate and meteorological monitors at unspecified times throughout the sampling year. A report will be forwarded to the Company within twenty days of the field or performance audits.

SECTION IV: Duration

This permit shall be valid from date of issuance until completion of mining as specified in either the application or Section I under permitted facilities.

SECTION V: General

A. Inspection

The recipient shall allow the Department's representatives access to the source at all reasonable times for the purpose of making inspections, surveys, collecting samples, obtaining data, and otherwise conducting all necessary functions related to this permit.

B. Waiver

The permit and all the terms, conditions, and matters stated herein shall be deemed accepted if the recipient fails to appeal as indicated below.

C. Compliance with Statutes and Regulations

Specific listing of requirements, limitations, and conditions contained herein does not relieve the applicant from compliance with all applicable statutes and administrative regulations including amendments thereto, nor waive the right of the Department to require compliance with all applicable statutes and administrative regulations, incuding amendments thereto.

D. Enforcement

Violations of limitations, conditions and requirements contained herein may constitute grounds for permit revocation, penalties or other enforcement as specified in Section 74-2-401 MCA.

E. Appeals

Any person or persons who are jointly or severally adversely affected by the Department's decision may request, within fifteen (15) days after the Department renders its decision, upon affidavit, setting forth the grounds therefore, a hearing before the Board. A hearing shall be held under the provisions of the Montana Administrative Procedures Act. The Department's decision on the application is not final unless fifteen (15) days have elapsed and there is no request for a hearing under this section. The filing of a request for a hearing postpones the effective date of the Department's decision until the conclusion of the hearing and issuance of a final decision by the Board.

AIR QUALITY PERMIT ANALYSIS

Application #1499

I. INTRODUCTION

Placer Amex has applied for an air quality permit for their gold mine and milling operation near Whitehall, Montana as described in Section I, Permitted Facilities.

Date of initial application was May 9, 1980. However, the application was deemed incomplete on June 4, 1980 because of missing information. Finally, after a number of meetings during the 1980 summer, Placer responded to the June 4, 1980 letter in writing on September 9, 1980, and on September 10, 1980, the application was deemed complete.

The mine and mill are located in an area which has an attainment status for all affected pollutants.

II. PROJECT DESCRIPTION

Placer Amex plans to produce 1,750,000 tons of gold ore and 2,275,000 tons of waste annually from an open pit on Mineral Hill.

Standard open pit mining techniques will be utilized to extract the ore. These techniques or methods will include drilling, blasting, loading hauling.

Milling will include crushing, grinding and conveying of gold ore for processing.

A more complete description of the actual operation is included in the permit applicaton and is hereto made part of with the exception as outlined in the September 9, 1980, response letter.

III. APPLICABLE REGULATIONS

Placer Amex Sunlight Mine is required under SubChapter 11, Permit, Construction and Operation of Air Contaminant Sources to obtain an air quality permit for their operation since the projected potential emissions are greater than 25 tons per year. Applicable Sections are listed below:

Sub-Chapter 11

Permit, Construction and Operation of Air Contaminant Sources

Rule 16.8.1101	Definitions
16.8.1102	When Permit Required -- Exclusions
16.8.1103	Emission Control Requirements
16.8.1104	Existing Sources and Stacks -- Permit Application Requirements

16.8.1105	New or Altered Sources and Stacks -- Permit Application Requirements
	Rule 16.8.1106 reserved
16.8.1107	Public Review of Permit Application
	Rule 16.8.1108 reserved
16.8.1109	Conditions for issuance of Permit
16.8.1110	Denial of Permit
16.8.1111	Duration of Permit
16.8.1112	Revocation of Permit
16.8.1113	Modification of Permit
16.8.1114	Transfer of Permit
16.8.1115	Inspection of Permit
	Rule 16.8.1116 reserved
16.8.1117	Compliance with Other Statutes and Rules
16.8.1118	Waivers

Emission point sources within the mine and mill are also subject to other state emission rules which are listed below:

Emission Standards

Rule 16.8.1401	Particulate Matter, Airborne
16.8.1403	Particulate Matter, Industrial Processes
16.8.1404	Visible Air Contaminants
16.8.818	Ambient Air Quality Standard for Settled Particulate Matter
16.8.821	Ambient Air Quality Standards for Total Suspended Particulate Matter
16.8.822	Ambient Air Quality Standard for Visibility

Copies of the recodified rules listed above are available from the Department on request.

IV. DEPARTMENT REVIEW OF THE APPLICATION

A. General

Review of open pit mines cannot be performed adequately utilizing conventional techniques, therefore the Department ha adopted a basic philosophy which is reflected by a statement in the State Implementation Plan (SIP).

> "Attempts by several groups, including EPA to develop computer models to relate mine emissions to ambient air quality have been rather unsuccessful. As previously mentioned, difficulties in determining emission rates and behavior, in the air of the emitted particulates are prime among the causes. thus, there is no adequate technique available to demonstrate that the standards will be attaned"...."Progress towards the standard will be documented by ambient sampling and implementation of control programs."

The Department continues this philosophy, but recognizes that some evaluation must be made. Therefore, estimation and prediction as well as monitoring plus requiring the best in technology control remain prime tools of the agency.

B. Procedures

The affected gold mining area is Class II and has an attainment status for all affected pollutants (particulates, sulfur dioxide, carbon monoxide, hydrocarbons, and ozone.) However, the Department also has a non-degradation policy which would require that Placer Amex Inc. install best technology and techniques to control their emissions.

C. Discussion

Placer Amex has prepared as part of their permit application lists of emisson factors, calculations, and projections for various operations occurring within both the mine and milling circuits.

The Air Quality Bureau has reviewed and summarized the projected "uncontrolled" and "controlled" emission estimates for the various types of operations within both the mine and mill. A table summary follows the conclusion of the discussion.

The permit application and its contents are included as part of this permit in addition to the Climatic factors, Fugitive Dust Emissions and calculation on projected emission from the mine and mill. However, the size of various scrubbing units has been changed from the original application and these changes are addressed under cover of the September 9, 1980 letter which was, as indicated earlier, a response to a Department June 4, 1980 letter of deficiency.

The "uncontrolled" emissions presented in the September 9, 1980, letter reflect those emissions after enclosure because enclosure is part of the normal construction scene for a gold milling operation. Otherwise a valuable product might be escaping to the atmosphere.

Documents included as part of the permit are:

1. Original Application plus location maps
2. September 9, 1980 cover letter
3. Follow up application of September 9, 1980
4. Estimated Fugitive Dust from Mine Operations - Golden Sunlight Project
5. Climatic Factors

Department projections indicate the operation should achieve compliance if the conditions as presented in Section II, Limitation and Conditions, are adhered to.

TABLE 1 EMISSION ESTIMATES Tons/Year

	Placer Amex		Air Quality Bureau	
	Uncontrolled	Controlled	Uncontrolled	Controlled
Truck Dumping	4.1	4.1	4.1	4.1
Loader Dumping	10.6	10.6	10.6	10.6
Primary Crushing	78.6(1)	32.7	78.6	32.7
Fine Ore Pile Feed Belt	17.5(1)	11.7	17.5	11.7
Fine Ore Pile	0.2	0.2	0.2	0.2
Fine Ore Reclaim	17.6(1)	12.2	26.3	12.2
Carbon Regeneration	6.6(2)	0.9	6.6	0.9
Refining Furnace	1.9(2)	0.4	1.9	0.4
Haul Roads	29.9(3)	6.0(4)	29.9	6.0
Drilling	1.1	0.7	1.1	0.7
Blasting	2.2	1.5	2.2	1.5
Ore laoding	7.9	5.3	7.9	5.3
Waste loading	6.9	6.9	6.9	6.9
Waste loading	5.3	5.3	5.3	5.3
Road Maintenance	1.9	1.9	1.9	1.9
Coarse Ore stockpile	0.14	0.14	0.14	0.14
Access Road	15.4	5.4	15.4	5.4
Total	207.84	105.94	216.54	105.94

Percent Control 49%

(1) Enclosed area

(2) Wet scrubbing

(3) Climatic Factor used to estimate final uncontrolled emission

(4) Speed Control, Watering and permanent dust palliatives

APPENDIX B

SURFACE WATER QUALITY DATA

STATE HEALTH DEPT. WATER QUALITY BUREAU HELENA, MONTANA 59601

STATE	MONTANA	COUNTY	JEFFERSON
LAT.-LONG.	461151N 112 459W	SAMPLE LOCATION	5N 4W 10DAC
STATION CODE	11-29-77	ANALYSIS NUMBER	77W3226
DATE SAMPLED	~~09-29-77~~	DRAINAGE BASIN	041E -BOULDER R.
TIME SAMPLED	1330	WATER FLOW RATE	46. CFS(M)
METHOD SAMPLED	GRAB	FLOW MEASUREMENT METHOD	GURLEY METER
SAMPLE SOURCE	STREAM	ALTITUDE OF LAND SURFACE	
WATER USE	MULTIPLE	TOTAL WELL DEPTH BELOW LS	
AQUIFER(S)		SWL ABOVE(+) OR BELOW LS	
SAMPLED BY	WQBH	SAMPLE DEPTH BELOW SURFACE	

SAMPLING SITE: BOULDER RIVER BELOW BOULDER MONTANA

	MG/L	MEQ/L		MG/L	MEQ/L
CALCIUM (CA)	25.7	1.280	BICARBONATE(HCO3)	73.	1.190
MAGNESIUM (MG)	3.1	0.259	CARBONATE (CO3)	0.	0.C
SODIUM (NA)	8.6	0.374	CHLORIDE (CL)	2.2	0.062
POTASSIUM (K)	2.8	0.072	SULFATE (SO4)	29.0	0.604
IRON (FE)			FLUORIDE (F)		
MANGANESE (MN)			PHOSPHATE(PO4 AS P)	.039	0.004
ALUMINUM (AL)			NO3+NO2 (TOT AS N)	.12	0.009
SUM CATIONS	40.196	1.985	SUM ANIONS	103.910	1.864

LABORATORY PH	8.00	TOT HARDNESS(MG/L-CACO3)	77
FIELD WATER TEMPERATURE (C)	4.0	TOT ALKALINITY(MG/L-CACO3)	60
UM-DISS. IONS MEAS.(MG/L)	144.1	LABORATORY TURBIDITY (JTU)	
LAB CONDUCTIVITY-UMHOS-25C	195.0	SODIUM ADSORPTION RATIO	0.4

ADDITIONAL PARAMETERS

AMMONIA,TOTAL(MG/L AS N)	.03	PHOSPHOROUS,TOT (MG/L-P)	.04
NITROGEN,KJL,TOT(MG/L-N)	.16		

REMARKS: BIOLOGICAL MONITORING

EXPLANATION: MG/L=MILLIGRAMS PER LITER MEQ/L=MILLIEQUIVILENTS PER LITER
ALL CONSTITUENTS DISSOLVED (DISS) EXCEPT AS NOTED. TOT=TOTAL SUSP=SUSPENDED
(M)= MEASURED(R)=REPORTED (E)=ESTIMATED M=METERS TR=TOTAL RECOVERABLE

SAMPLE NO 03 SAMPLER GI HANDLING 31C1 ANALYST ROB LAB WQBH
COMPLETED 03-14-78 COMPUTER RUN 03/22/78 DATA C975/PROG 0876 FUND 0662

STND DEV. ION BALANCE -1.01	CA	MG	NA	K	CL	SO4	HCO3	CO3	NO3
SEGMENT NPDES	64.5	13.0	18.9	3.6	3.3	32.5	64.1	0.0	0.0

CALC. MEQ/L= 1.877 TO 2.074 77W3226

```
STATE HEALTH DEPT.        WATER QUALITY BUREAU          HELENA, MONTANA  59601

            STATE  MONTANA                             COUNTY  GALLATIN
       LAT.-LONG.  455351N 1113543W           SAMPLE LOCATION   2N  1E 27BCC
     STATION CODE                             ANALYSIS NUMBER  78W0334
     DATE SAMPLED  03-23-78                    DRAINAGE BASIN  041G -JEFFERSON
     TIME SAMPLED  1030                       WATER FLOW RATE
   METHOD SAMPLED  GRAB               FLOW MEASUREMENT METHOD
    SAMPLE SOURCE  STREAM            ALTITUDE OF LAND SURFACE
        WATER USE  MULTIPLE        TOTAL WELL DEPTH BELOW LS
       AQUIFER(S)                    SWL ABOVE(+) OR BELOW LS
       SAMPLED BY  WQBH           SAMPLE DEPTH BELOW SURFACE

           SAMPLING SITE: JEFFERSON RIVER AT THREE FORKS

                     MG/L      MEQ/L                          MG/L      MEQ/L
  CALCIUM (CA)                          BICARBONATE(HCO3)
MAGNESIUM (MG)                            CARBONATE (CO3)
   SODIUM (NA)                             CHLORIDE  (CL)
POTASSIUM  (K)                              SULFATE (SO4)
                                           FLUORIDE   (F)
                                      PHOSPHATE(PO4 AS P)    0.029      0.003
                                       NO3+NO2 (TOT AS N)    0.120      0.009

                    ------     ------                       ------     ------
     SUM CATIONS      0.0        0.0            SUM ANIONS   0.149      0.011

                LABORATORY PH      8.30     TOT HARDNESS(MG/L-CACO3)
FIELD WATER TEMPERATURE (C)        9.0     TOT ALKALINITY(MG/L-CACO3)
 SUM-DISS. IONS MEAS.(MG/L)                LABORATORY TURBIDITY (NTU)
 LAB CONDUCTIVITY-UMHOS-25C      470.0       SODIUM ADSORPTION RATIO

                  A D D I T I O N A L   P A R A M E T E R S
 PHOSPHORCUS,TOT (MG/L-P)         .073    AMMONIA,TOTAL(MG/L AS N)       .02
 NITROGEN,KJL,TOT(MG/L-N)         .38




REMARKS:  BIOLOGICAL MONITORING

EXPLANATION: MG/L=MILLIGRAMS PER LITER  MEQ/L=MILLIEQUIVILENTS PER LITER
ALL CONSTITUENTS DISSOLVED (DISS) EXCEPT AS NOTED. TOT=TOTAL SUSP=SUSPENDED
(M)= MEASURED(R)=REPORTED (E)=ESTIMATED M=METERS TR=TOTAL RECOVERABLE
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
SAMPLE NO 15         SAMPLER  GL1    HANDLING 5303   ANALYST   EA   LAB  WCBH
COMPLETED 03-31-78  COMPUTER RUN 05/03/78  DATA C975/PROG 0876 FUND 0662
STND DEV. ION BALANCE  0.13       CA   MG   NA    K   CL  SO4  HCO3  CO3  NO3
SEGMENT        MPDES             0.0  0.0  0.0  0.0 33.3 33.3  0.0 33.3  0.0
CALC. MEQ/L= INSUFFICIENT DATA                                         78W0334
```

STATE HEALTH DEPT. WATER QUALITY BUREAU HELENA, MONTANA 59601

STATE	MONTANA	COUNTY	MADISON
LAT.-LONG.	455116N 1115629W	SAMPLE LOCATION	1N 3W 11BD
STATION CODE		ANALYSIS NUMBER	78W0005
DATE SAMPLED	01-04-78	DRAINAGE BASIN	041G -JEFFERSON
TIME SAMPLED	1300	WATER FLOW RATE	——
METHOD SAMPLED	GRAB	FLOW MEASUREMENT METHOD	
SAMPLE SOURCE	STREAM	ALTITUDE OF LAND SURFACE	
WATER USE		TOTAL WELL DEPTH BELOW LS	
AQUIFER(S)		SWL ABOVE(+) OR BELOW LS	
SAMPLED BY	WQBH	SAMPLE DEPTH BELOW SURFACE	

Cardwell

SAMPLING SITE: SLOUGH BELOW TRAIN WRECK NEAR JEFFERSON R

	MG/L	MEQ/L		MG/L	MEQ/L
CALCIUM (CA)			BICARBONATE(HCO3)		
MAGNESIUM (MG)			CARBONATE (CO3)		
SODIUM (NA)			CHLORIDE (CL)		
POTASSIUM (K)			SULFATE (SO4)		
IRON (FE)			FLUORIDE (F)		
MANGANESE (MN)			PHOSPHATE(PO4 AS P)	31.9	3.091
ALUMINUM (AL)			NO3+NO2(TOT AS N)		
SUM CATIONS	0.0	0.0	SUM ANIONS	0.0	0.000

LABORATORY PH	7.00	TOT HARDNESS(MG/L-CACO3)	
FIELD WATER TEMPERATURE (C)	1.0	TOT ALKALINITY(MG/L-CACO3)	
-DISS. IONS MEAS.(MG/L)		LABORATORY TURBIDITY (JTU)	
LAB CONDUCTIVITY-UMHOS-25C	658.0	SODIUM ADSORPTION RATIO	

ADDITIONAL PARAMETERS

PHOSPHOROUS,TOT (MG/L-P) 32.1

REMARKS: POLLUTION INVESTIGATION ICE COVERED

EXPLANATION: MG/L=MILLIGRAMS PER LITER MEQ/L=MILLIEQUIVILENTS PER LITER
ALL CONSTITUENTS DISSOLVED (DISS) EXCEPT AS NOTED. TOT=TOTAL SUSP=SUSPENDED
(M)= MEASURED(R)=REPORTED (E)=ESTIMATED M=METERS TR=TOTAL RECOVERABLE

SAMPLE NO 1 SAMPLER PCG HANDLING 21CO ANALYST EA LAB WQBH
COMPLETED 01-24-78 COMPUTER RUN 02/10/78 DATA 0975/PROG 0876 FUND 0662

		CA	MG	NA	K	CL	SO4	HCO3	CO3	NO3
STND DEV. ION BALANCE	0.00									
SEGMENT	MPDES	0.0	0.0	0.0	0.0	33.3	33.3	0.0	33.3	0.0

CALC. MEQ/L= INSUFFICIENT DATA

78W0005

PLACER AMEX INC.

P. O. BOX 678 • WHITEHALL, MONTANA 59759 • (406) 287-3427

December 9, 1980

Ms. Pat Howe
Department of State Lands
Capitol Station
Helena, MT 59601

Dear Pat:

Attached is a copy of the chemical analysis results for a water sample taken from Well #1 in August 1980. These results compare reasonably well with the analytical results obtained from a water sample taken from the same well in 1974. Well #1 is located directly below Spring B which is above the proposed tailing area and just west of the existing road. Spring A is in the same general area but is just east of the road.

The expected average total fresh water requirement for the mine and mill operations is around 700 gallons per minute. However, this water requirement will vary seasonally and could be double this rate during certain periods of time.

Yours Sincerely,

T. J. Smolik

TJS/bls
cc: File w/ Attachment

A subsidiary of Placer Development Limited

E CALIFORNIA BUILDING • SUITE 2500 • SAN FRANCISCO • CALIFORNIA 94111 • (415) 986-0740

```
   TANA BUREAU OF MINES AND GEOLOGY          WATER QUALITY ANALYSIS
  UTTE,MONTANA  59701  (406)496-4101         LAB NO. 8001476

                  STATE                                       COUNTY
   LATITUDE-LONGITUDE   D  '  "N      D  '  "W   SITE LOCATION
      UTM COORDINATES Z    N          E                MBMG SITE
      TOPOGRAPHIC MAP                                STATION ID
     GEOLOGIC SOURCE 110ALVM*        *        *  SAMPLE SOURCE
       DRAINAGE BASIN                     LAND SURFACE ALTITUDE
   AGENCY + SAMPLER PRIV*GFZ                    WATER FLOW RATE
        BOTTLE NUMBER                         FLOW MEAS METHOD
         DATE SAMPLED                                STAFF GAGE
         TIME SAMPLED    :    HOURS                STREAM STAGE
       LAB + ANALYST MBMG*FNA                   DEPTH TO SAMPLE
        DATE ANALYZED 29-AUG-80             TOTAL DEPTH OF WATER
      SAMPLE HANDLING 4300 .                       STREAM WIDTH
       METHOD SAMPLED
            WATER USE

        SAMPLING SITE GOLDEN SUNLIGHT *
       DRAINAGE BASIN

                      MG/L      MEQ/L                              MG/L     MEQ/L
   CALCIUM   (CA)     50.8       2.53 BICARBONATE   (HCO3)         9.3      0.15
   MAGNESIUM (MG)     40.8       3.36 CARBONATE      (CO3)         0.
   SODIUM    (NA)     29.7       1.29 CHLORIDE        (CL)        14.4      0.41
   POTASSIUM  (K)     11.5       0.30 SULFATE        (SO4)       315.       6.56
   IRON      (FE)      2.17      0.12 NITRATE       (AS N)          .14     0.01
   MANGANESE (MN)       .54      0.02 FLUORIDE         (F)         1.1      0.06
   SILICA  (SIO2)     61.9            PHOSPHATE TOT (AS P)

     TOTAL CATIONS               7.62        TOTAL ANIONS                   7.18

     STANDARD DEVIATION OF ANION-CATION BALANCE   (SIGMA)       -2.01

                LABORATORY PH       5.48    TOTAL HARDNESS AS CACO3    294.78
      FIELD WATER TEMPERATURE              TOTAL ALKALINITY AS CACO3     7.63
   CALCULATED DISSOLVED SOLIDS    532.63     SODIUM ADSORPTION RATIO     0.75
       SUM OF DISS. CONSTITUENT   537.35       RYZNAR STABILITY INDEX   12.24
 LAB SPEC.COND.(MICROMHOS/CM)     735.8    LANGLIER SATURATION INDEX    -3.38

       PARAMETER                  VALUE           PARAMETER                VALUE
 ALUMINUM,TR (MG/L AS AL)          2.9     COPPER,TR (MG/L AS CU)           .40

 REMARKS: GROUND WATER *
     LAB: HIGH SIGMA DUE TO CATIONS REPORTED ON RAW ACIDIFIED SAMPLE--NO FU *

 EXPLANATION:  MG/L = MILLIGRAMS PER LITER, UG/L = MICROGRAMS PER LITER, MEQ/L =
 MILLIEQUIVELENTS PER LITER.  FT = FEET, MT = METERS.  (M) = MEASURED, (E) =
 ESTIMATED, (R) = REPORTED.  TR = TOTAL RECOVERABLE.  TOT = TOTAL.

                        QW   WA   S2   W1   OW   PW   AT       OTHER
 OTHER AVAILABLE DATA
 OTHER FILE NUMBERS:

             PROJECT:                                COST:
      LAST EDIT DATE:  12-SEP-80                       BY:  TP *CLG
  PROCESSING PROGRAM:  F1730P V2 (8/9/80)        PRINTED:  26-SEP-80

                    PERCENT MEQ/L (FOR PIPER PLOT)
                   CA    MG    NA     K    CL   SO4  HCO3
                   33    44    16     3     5    91     2

 NOTE:  IN CORRESPONDENCE, PLEASE REFER TO LAB NUMBER:  8001476
```

FINAL

APPENDIX C

SOIL SURVEY DATA

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SUBJECT: Soil Survey

DATE: 11/17/80

TO: Don Jenkins
Placer Amex, Sunlight Mine
Whitehall, MT 59759

Don:

Attached is the soil survey report you requested on the area of planned reclamation in the proposed open pit mining project.

The report includes a temporary soils map with descriptions in universally accepted terminology. Please be advised that the symbols used on the map are only temporary until Jefferson County completes and publishes it's survey. A seeding recommendation is also included for the tailing pond area and overburden dump sites. These recommendations are subject to change as present research is still finding different and new varieties more adaptable to reclamation procedures.

Sincerely,

Philip F. Sandoval

Philip F. Sandoval
Soil Conservationist
Whitehall Field Office

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Seeding Recommendations

	*lbs. per Acre
Blue Bunch Wheatgrass	6
Crested Wheatgrass "Nordan"	2
Beardless Wheatgrass	6
Thickspike Wheatgrass	6
or	
Western Wheatgrass "Rosanna"	
Slender Wheatgrass	2
Yellow Sweet Clover	1
	23

*These are pure live seed recommendations (PLS). The lb/Ac should be doubled if broadcasted.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Sunlight Mine Soil Survey

This Soil Survey was conducted at the request of the Placer Amex Incorporated. This survey is a preliminary work and hence is subject to revision when incorporated into the progressive soil survey of Jefferson County.

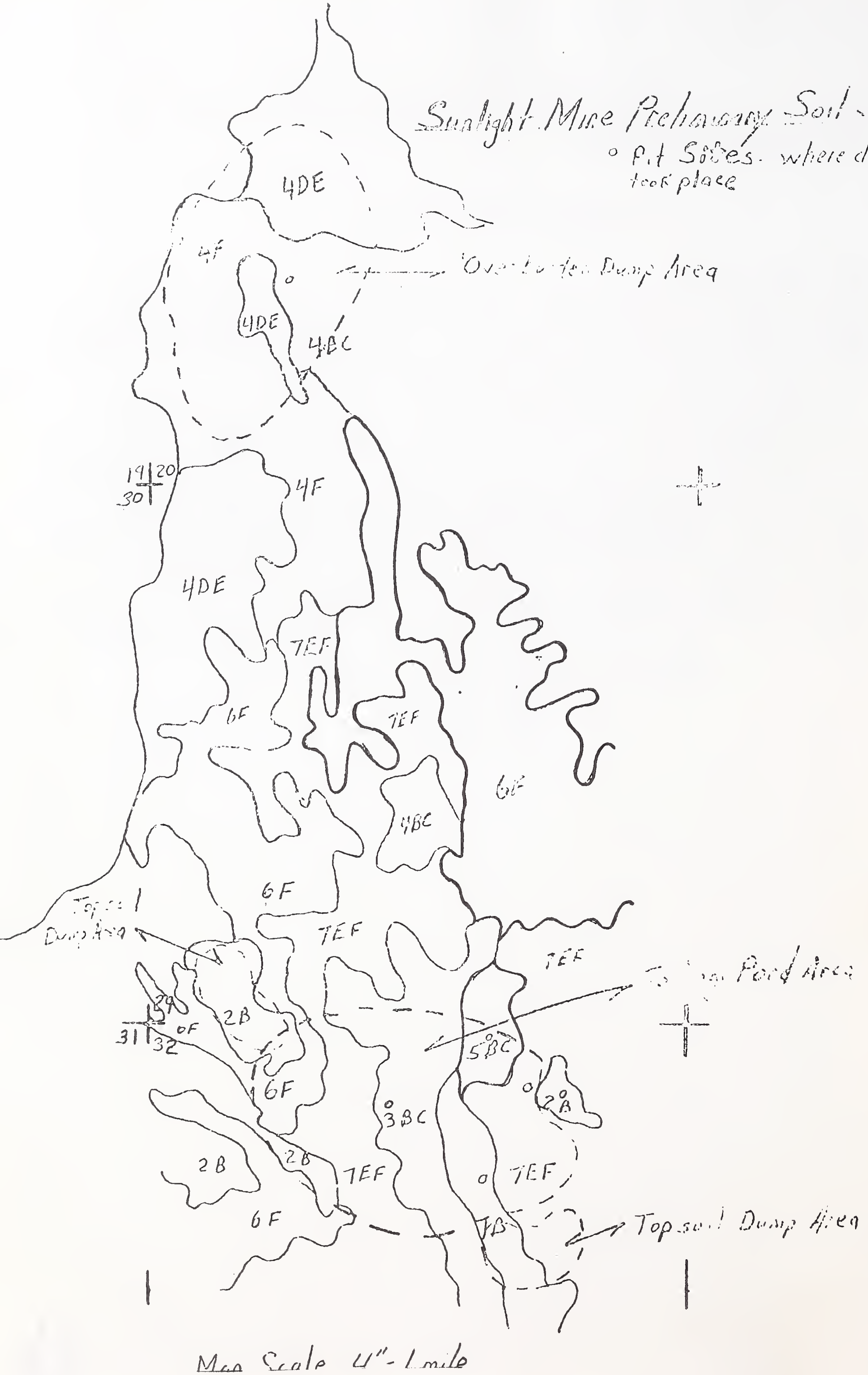
The survey area includes parts of Sections 20, 29 and 32; Township 2N; Range 3W.

Mapping was conducted October 20 and 21, 1980. Typical profiles were described from backhoe pits the same week.

The term "topsoil" usually refers to the surface layer. Over most of this area surface layers are relatively thin. Reclamation could be enhanced by stockpiling all or part of the subsoil, or the surface layer and the underlying material. Range production may even be improved on the gravelly and shallow soils and soils on steep slopes by careful reclamation. Should further assistance be necessary in this regard contact the Soil Conservation Service at Whitehall, Montana.

Jefferson Silver-Bow Soil Survey Party
Ken Drexil
Ed Brinken
Don Strom

Sunlight Mine Preliminary Soil Survey



○ Pit Sites - where detailed soils took place

Map Scale 4" - 1 mile

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Mapping Unit Legend

1B	Borollic Haplargid, Fine-Loamy over Sand or Sandy Skeletal, Mixed, 2-4 percent slopes
2B	Borollic Calciorthid, Coarse-Silty, Mixed, 2-4 percent slopes
3BC	Borollic Haplargid, Loamy-Skeletal, Mixed - - Borollic Calciorthid, Coarse-Loamy, Carbonitic, complex, Channeled, 2-8 percent slopes
4BC	Borollic Camborthid, Loamy-Skeletal, Mixed, 2-8 percent slopes
4DE	Borollic Camborthid, Loamy-Skeletal, Mixed, 8-25 percent slopes
4F	Borollic camborthid, Loamy-Skeletal, Mixed, 25-60 percent slopes
5BC	Typic Torriorthents, Sandy-Skeletal, Mixed, Frigid, 2-8 percent slopes
6F	Ustic Torriorthents, Loamy, Mixed (calcareous), Frigid, Shallow - - Aridic Calciborolls, Sandy-Skeletal, Mixed - - Rock Outcrop, complex, 35-80 percent slopes
7EF	Borollic Calciorthid, Coarse-Loamy, Mixed - - Aridic Calciborolls, Sandy-Skeletal, Mixed, complex, 15-45 percent slopes

APPENDIX D

SEISMIC REOCCURRENCE DATA

DRAFT

Memo

To: Ralph Driear

From: David Nimick

Re: Seismic Analysis for Placer Amex Tailings Dam

Date: 12/5/80

Montana lies in a north-trending zone called the Intermountain Seismic Belt (Smith and Sbar, 1974) in which earthquakes occur. This earthquake zone branches at Yellowstone National Park; one belt of activity trends westward into central Idaho and the other trends north and then northwest through Three Forks, Helena, and Flathead Lake. The Lombard (Townsend area) and Madison (Yellowstone Park to Three Forks area) fault systems are the identified fault systems with recent earthquake activity closest to the mine site.

The Lombard fault system consists of numerous faults. A northwest-trending zone of normal faults extends from Deep Creek southward to Six Mile Creek. Total cumulative displacements (down to the west) of up to about 600 m (about 2,000 ft) occur on these faults. The most recent movement occurred after the Miocene period. The Clarkston Valley Fault also is post-Miocene (Pardee 1926 and 1950) and might have been responsible for the 1925 Clarkston earthquake of magnitude 6.75 because Clarkston Valley was the area of highest intensity as estimated on the Modified Mercalli Scale. The Clarkston Fault, which bounds the valley on the east, apparently is the youngest fault observed. No fresh displacement on the Clarkston Fault occurred at the surface in 1925, although ground cracks occurred at several locations. Microearthquake surveys show that this fault is very active today (Qamar and Hawley 1979). The Helena shock of 1935 and the Clarkston quake of 1925 may be representative of the earthquake potential on all faults in the Helena-Bozeman region. Several arguments support this conclusion. These faults are similar to the many normal faults in the region which border Tertiary intermontane basins in western Montana. Present-day seismicity indicates that these faults and others are presently active. Bold, steep scarps on the north-trending Madison and Tendoy faults in southwestern Montana indicate that large earthquakes on these normal faults occurred in recent time.

The major earthquakes in Montana during the twentieth century are listed below in Table 1.

TABLE 1 -- Major earthquakes in Montana since 1900

Date	Location	Felt Area (mi^2)	Maximum intensity[a]	Magnitude
5/15/09		500,000	VII	6.5?
6/27/25	Clarkston (Three Forks)	310,000	IX	6.75
10/18/35	Helena	230,000	VIII	6.25
10/31/35	Helena	140,000	VIII	6
11/23/47	Madison Co. SW MT	150,000	VIII	6.25
8/17/59	Hebgen Lake	600,000	X	7.1

SOURCE: Coffman and von Hake 1973.

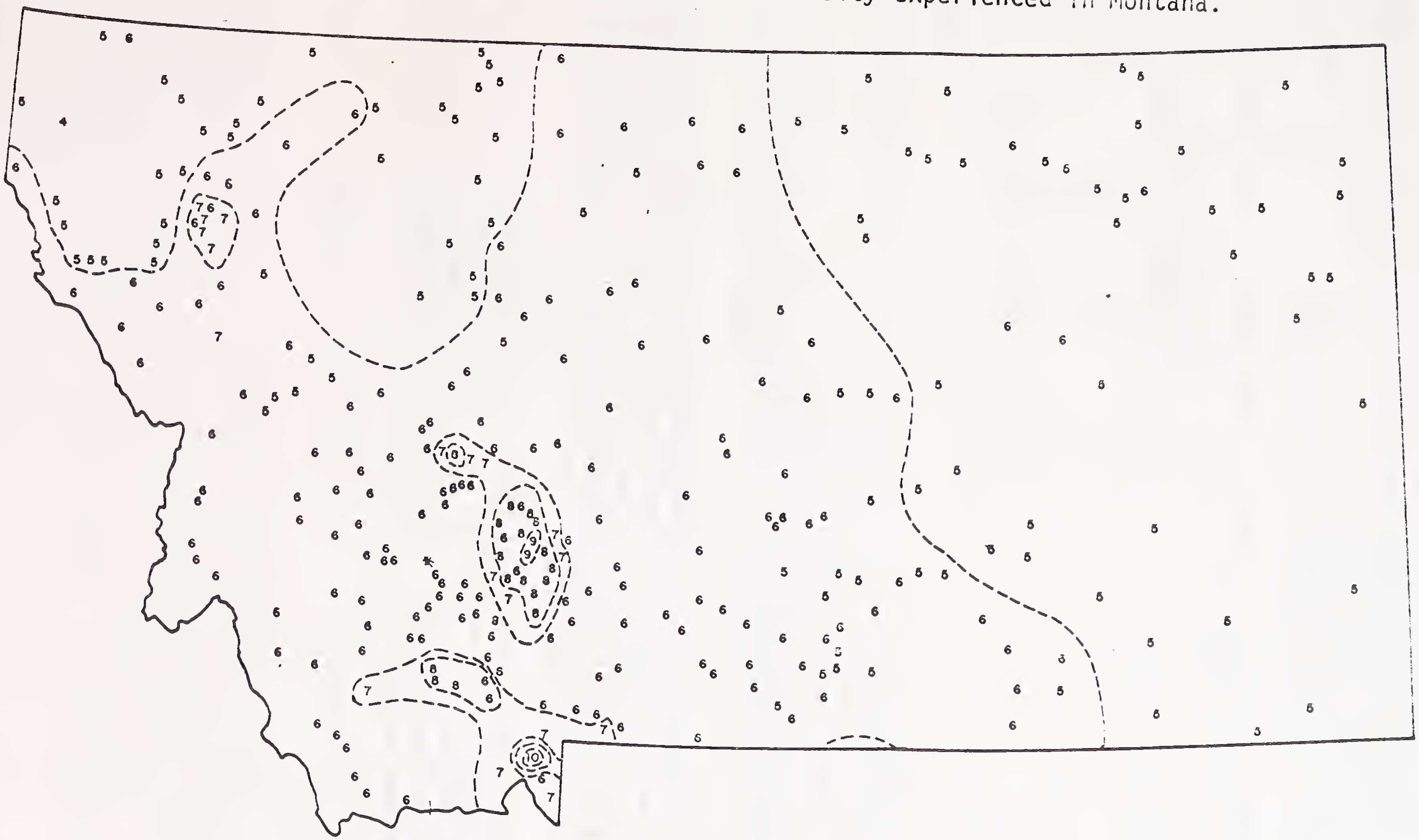
CONVERSIONS: 1 m^2 = 2.590 km^2

[a] According to the Modified Mercalli Scale.

Reported intensities of all major earthquakes in Montana have been re-examined by DNRC (1979). The data from all earthquakes were superimposed to produce Figure 1, which shows the maximum earthquake intensity (according to the Modified Mercalli Scale) ever reported in Montana. Contours which roughly separate zones of different intensity also are drawn.

Whether a map such as Figure 1 should be used directly for design purposes is debatable; the issue is whether maximum reported historical intensities should be used. Because Figure 1 shows maximum historical intensities and not maximum possible intensitities, it probably should be considered to represent the lower range of expected intensities for which to design. The justification for this is that generally a design must accomodate an earthquake at least as large as the biggest earthquake recorded in the past.

FIGURE 1. Maximum modified Mercalli intensity experienced in Montana.



SOURCE: (USDC 1977[a]) NOAA computer intensity data file, and Pardee 1926; interpreted by University of Montana Earthquake Research Laboratory 1979.

NOTE: All historical quakes, 1925-1977.

[a] While Roman numerals are generally used to indicate a measure of intensity, intensity here is indicated in Arabic numerals to make the map more readable.

Intensities sometimes are used to estimate ground acceleration at a site. Many authors have found relationships between these quantities (see Bolt 1975 for a summary), but there is a great deal of variation in the findings. The problem is that the earthquake mechanism and local geology can complicate an otherwise predictable relationship between intensity and acceleration. Table 2 gives published range of acceleration as a function of intensity.

Table 2 -- Range of acceleration as functions of intensity

Intensity[a]	Published Range of Acceleration (g's)
VI	.005 - .065
VII	.010 - .20
VIII	.025 - .35
IX	.05 - .90
X	.10 - >1.0

SOURCE: After Bolt 1975.

[a] According to the Modified Mercalli Scale.

The maximum reported intensity in the vicinity of the mine is VI which corresponds to an acceleration of less than 0.10 g.

Few recorded accelerations have been taken in Montana, especially close to an epicenter. Accelerograms have been recorded at Hungry Horse Dam in northwestern Montana, Great Falls, Helena, Butte, and Bozeman from the 1935, 1947, and 1959 earthquakes (see appropriate issues of United States Earthquakes and Ulrich 1936).

Numerous studies have been completed on the subject of acceleration as opposed to distance as a function of earthquake magnitude; the curves designed by Schnabel and Seed (1973) are commonly used (also Bolt 1975 and Page et al. 1975). In Table 3, the Schnabel and Seed curves give approximate acceleraions in relation to epicentral distance and magnitude.

Table 3 --

Acceleration in relation to magnitude and distance to epicenter[a]

Distance in km to Fault	Acceleration Magnitude 5	Magnitude 6	Magnitude 7
5	.35g	.50g	.65g
10	.25	.35	.48
20	.12	.22	.35
40	.05	.10	.19
60	.03	.05	.11

SOURCE: Schnabel and Seed 1973.

CONVERSION: 1 km = .622 mi

[a] Each value has an expected uncertainty; these values are not given here, but are mostly in the range from ± .05 to ± .07g.

Given that the 1925 Clarkston earthquake was 40 km from the mine site (DNRC, 1979) and a magnitude 7 earthquake, acceleration at the mine site would be 0.19g.

Various investigators have conducted seismic zoning studies in which contours of effective peak horizontal ground acceleration (EPA) were estimated for the area of the site. These studies are based on both statitistical analysis of the seismic history and a general appraisal of regional faulting and tectonics. The following listing enumerates these estimates.

EPA	Reference	Remarks
0.20g	Algermissen & Perkins (1976)	90 percent probability of not being exceeded in 50 years.
0.17g	Applied Technology Council (1978)	90 percent probability of not being exceeded in 50 years.

A critical factor in assessing earthquake hazard is determining the probability that an event of a given size or greater will occur within a specified period of time. Because Placer Amex estimates a life-length of 20 years for the proposed pipeline, that is the time frame used to determine the level of earthquake risk. If a permissible level of risk can be established, the extent of the mitigating design features can be determined. To do this, it is necessary to determine the size of an event for which a design must be made in order to be, for example, 95 percent confident that the event would not occur in the next twenty years. In order to address these issues, analyses were made of earthquake recurrence rates as a function of magnitude for past and recent earthquakes in Montana (DNRC, 1979).

Earthquakes recur more or less according to the equation:

$$\log N_C = a - b M$$

where: M = magnitude of earthquke
N_C = cumulative number of events having a magnitude which equals or exceeds M

and a and b are constants characteristic of the level of activity of a particular region

The constant a depends not only on the activity of a region, but also on the size of the region and the time period over which the equation applies.

Once a and b have been determined, the probabilities of earthquake recurrence at or below a given magnitude may be computed. This equation may be cautiously extrapolated to magnitudes somewhat greater than those for which data exist. The recurrence rates in the the Three Forks area for magnitude 5, 6, and 7 earthquake are 14, 70 and 364 years respectively (DNRC, 1979).

The level of risk can be calculated for the project life of 20 years.

Table 4 -- Risk levels

$P(x=o)$ (Probability of not being exceeded)	T/t (Return time during twenty-year life of project)
.37	1.
.50	1.44
.75	3.48
.90	9.49
.95	19.5
.99	99.5

Table 4 indicates that at a .95 probability of not being exceeded during a project lifetime of twenty years, the earthquake magnitude for which the ~~pipeline~~ project is designed must have a return time:

$$T = 19.5t = 19.5 \times 20 \text{ years} = 390 \text{ years}$$

This return time corresponds roughly to magnitude 7 in the Three Forks region. Thus, it would be advisable to design in this area to accomodate an earthquake magnitude of at least 7.

The historical record of earthquakes in Montana is short--about one hundred years for events of large magnitude. It would be difficult under any circumstances to obtain a reliable estimate of the actual recurrence rate from historical seismic data. A critical question is whether an earthquake of magnitude 7 could occur in this region. Most earthquake activity in Montana is produced by a stress system which results in a predominance of normal and strike-slip faulting (Smith and Sbar 1974). Faults in the Helena region certainly conform to this pattern. Since earthquakes have occurred in Montana at magnitudes of 6.75 and 7.1, it seems appropriate to assume that an earthquake of magnitude 7 may be possible near Three Forks.

There is a rough relationship between the magnitude of an earthquake and the length of the fault rupture which accompanies it (Hoffman 1974, Bolt 1975). Although the relationship appears to be regionally dependent and has not been established for Montana, it is useful to examine some representative values and then estimate its limits on the size of an earthquake. Estimates were made on the basis of empirical relationships between length of surface rupture and earthquake magnitude summarized by Slemmons (1977). Estimates were made based on the assumption of fault breakage for the full mapped length of the faults and one-half the mapped length of the fault. Effective peak horizontal ground acceleration (EPA) at the site produced by the hypothetical earthquakes was estimated from attenuation curves developed by Schnabel and Seed (1973). Results are as follows:

Fault System	Distance From Site	Full Fault Length	Maximum Credible Earthquake Full Length	Maximum Credible Earthquake One-Half Length	Maximum EPA At Site
Madison	48 km	58 km	7.1 m	6.8 m	0.15g
Lombard	42 km	69 km	7.2 m	6.9 m	0.18g

In summary, various methods of predicting ground acceleration at the mine site produce similar results. Seismic zoning studies predict accelerations between 0.17g and 0.20g. The acceleration predicted by empirical relations between magnitude, distance from epicenter and acceleration is 0.19g based on a magnitude 7 earthquakes. A magnitude 7 design earthquake is calculated for the 95% level of risk and a magnitude 7.2 maximum credible earthquake is calculated by fault length analysis.

References

Algermissen, S. T., and Perkins, D. M., 1976, A Probabilistic Estimate of Maximum Acceleration in Rock in the Contiguous United States, U.S. Geological Survey Open File Report No. 76-416.

Applied Technology Council, 1976, Working Draft of Recommended Comprehensive Seismic Design Provisions for Building, Document No. ATC-3-04.

Bolt, B. A. 1975. Geological hazards. Springer-Verlag.

Coffman, J. L. and C. A. von Hake. 1973. Earthquake history of the United States. U.S. Department of Commerce, NOAA, EDS, public 41-1.

Dept. Natural Resources & Conservation (1979) Earthquake hazard to the proposed Northern Tier Pipeline in Montana; Northern Tier Report No. 4.

Hoffman, R. B. 1974. Factors in the specification of ground motions for earthquake design in California, state of the art for assessing earthquake hazards in the United States. Report 3. U.S. Army Engineer Waterways Experiment Station. Misc. Paper S-73-1.

Qamar, A. and B. Hawley. 1979. Recent earthquake activity near Three Forks Basin, Montana. Unpublished.

Page, R. A., D. M. Boore, and J. H. Dieterich. 1975. Estimation of bedrock motion at the ground surface. Studies for seismic zonation of the San Francisco Bay Region. U.S.G.S. Survey Prof. Paper 941-A, A31-A38.

Schnabel, P. B. and H. B. Seed. 1973. Accelerations in rock for earthquakes in the Western United States. bull. Seism. Soc. Am. 63:501-516.

Slemmons, D. B., 1977, State-of-the-art for Assessing Earthquake Hazards in the United States, Faults and Earthquake Magnitude, U.S. Army Engineer Waterways Experimental Station Soils and Pavement Laboratory, Miscellaneous Paper S-7301, Report 6.

Smith, R. B., and Sbar, M. L., 1974, Contemporary Tectonics and Seismicity of the Western United States with Emphasis on the Intermountain Seismic Belt, Geological Society of American Bulletin, Vol. 85, pp. 1205-1218.

Ulrich, F. P. 1936. Helena earthquakes. Bull. Seism. Soc. Am. 26:323-339.

APPENDIX E

SCHOOL ENROLLMENT DATA

"Trojan Country"

G. NICK HOLMES - High School Principal

FRANK MAGEE - Elementary Principal

Board Chairman - Dr. GAYLE SACRY

Board Clerk - PAULINE GLESS

WHITEHALL PUBLIC SCHOOLS
P.O. Box 400

Phone 287-3862 or 287-5508
CONSOLIDATED SCHOOL DISTRICT NO. 4, 47, & 2
JEFFERSON & MADISON COUNTIES

WHITEHALL, MONTANA 59759
GENE DILLMAN, Superintendent

September 30, 1980

Patricia J. Howe
Department of State Lands
1625 Eleventh Ave.
Helena, MT 59601

Dear Patricia:

This is confirmation of a prior telephone conversation concerning the expansion of mining activities in the Whitehall area.

The Whitehall School District's enrollment is declining, particularly at the Elementary level. The capacity of the K - 12 system is approximatly 850 students. Our current enrollment is 711.

We have no official plans at this time for expansion as there is no need. The district could care for approximately 140 more students, K- 12.

Thank you for your interest.

Sincerely,

Gene Dillman, Superintendent

GD:mmb

APPENDIX F

TAILING CHEMICAL COMPOSITION

MIDECO

MICROBIOLOGICAL DEVELOPMENT & CONTROL, INC.

420 CHIPETA WAY · SUITE 280
UNIVERSITY OF UTAH RESEARCH PARK
SALT LAKE CITY, UTAH 84108
TELEPHONE: (801) 582-3136
TWX 910-925-5258

SAMPLE SOURCE:	Placer Amex, Inc.
LABORATORY NUMBER:	29714
IDENTIFICATION:	Tailings Pulp Sample (Tailings #1)
DATE STARTED:	10-14-80
DATE COMPLETED:	10-22-80

RESULTS:

Parameter	mg/l (ppm) in a 10% w/v leachate
Boron	0.00
Carbonate	30.0
Chloride	1.90
Cyanide	0.31
Fluoride	0.18
Sulfate	1.89
Sulfide	3.60
Sulfite	1.50

Parameter	mg/l (ppm) in 1.3% w/v acid solution	% of original pulp sample
Antimony	0.00	0.00
Aluminum	34.0	0.255
Arsenic	0.00	0.00
Barium	19.8	0.1485
Cadmium	0.00	0.00
Calcium	20.00	0.150
Chromium (Total)	0.00	0.00
Copper	1.65	0.0120
Iron	530.0	3.9675
Lead	0.58	0.00435
Magnesium	14.75	0.1103
Manganese	2.75	0.02063
Mercury	0.003	0.000022
Molybdenum	0.00	0.00
Nickel	9.50	0.07117
Potassium	0.549	0.00418
Selenium	1.10	0.00825
Silver	0.00	0.00
Sodium	50.0	0.37425
Zinc	1.750	0.01313

David W Gayer
Study Director

J Nelson
Jerry R. Nelson, Ph.D.
Laboratory Director

MIDECO

MICROBIOLOGICAL DEVELOPMENT & CONTROL, INC.

420 CHIPETA WAY - SUITE 280
UNIVERSITY OF UTAH RESEARCH PARK
SALT LAKE CITY, UTAH 84108
TELEPHONE: (801) 582-3136
TWX 910-925-5258

SAMPLE SOURCE: Placer Amex, Inc.
LABORATORY NUMBER: 29715
IDENTIFICATION: Liquid Leachate Sample (Solution #2)
DATE STARTED: 10-14-80
DATE COMPLETED: 10-22-80
RESULTS:

Analysis	Result
Acidity	0.00 mg/1
Alkalinity (Total)	635.0 mg/1
Bicarbonate	0.00 mg/1
Boron	0.00 mg/1
Bromide	0.00 mg/1
Carbonate	410.0 mg/1 as $CaC0_3$
Chloride	274.9 mg/1
Cyanide	51.20 mg/1
Fluoride	3.30 mg/1
Hydroxide	225.0 mg/1
pH	11.51
Dissolved solids	1,125. mg/1
Specific conductivity	680. ohms (equal to 490 ppm NaC1)
Sulfate	400.0 mg/1
Sulfide	15.6 mg/1
Sulfite	6.0 mg/1

Metals	ppm (mg/1)
Antimony	0.00
Aluminum	0.712
Arsenic	0.00
Barium	0.074
Cadmium	0.00296
Calcium	88.97
Chromium	0.00

Page Two
Placer Amex, Inc.
Lab No. 29714

Metals	ppm (mg/1)
Copper	65.24
Iron	0.311
Lead	0.0445
Magnesium	0.215
Manganese	0.065
Mercury	0.000163
Molybdenum	0.593
Nickel	0.304
Potassium	61.54
Selenium	0.00
Silver	0.0047
Sodium	1,168.0
Zinc	1.946

Study Director

Jerry R. Nelson, Ph.D.
Laboratory Director

kb

100 copies of this publication were produced at a unit cost of $2.33 per copy, for a total cost of $292.45 which includes $233.45 for printing and $59.00 for distribution.

These printing and distribution costs were paid for by Dept. of State Lands pursuant to Title 75, Chapter 1, part 2, MCA